

Historic, archived document

Do not assume content reflects current scientific knowledge, policies, or practices.

763C

File Copy

RECEIVED
NORTH-EASTERN FOREST
EXPERIMENT STATION
SEP 23 1939

UNITED STATES DEPARTMENT OF AGRICULTURE

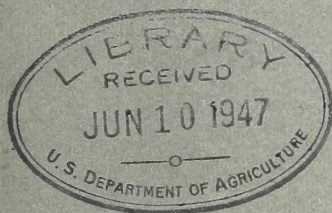
FOREST SERVICE

FOREST RESEARCH ACTIVITIES

FOREST MANAGEMENT
RANGE MANAGEMENT
FOREST PRODUCTS

FOREST ECONOMICS
FOREST SURVEY
FOREST INFLUENCES

JUN - 1939



FOREST RESEARCH
BI-MONTHLY REPORT

June 1, 1939

FOREST RESEARCH
BI-MONTHLY REPORT

June 1, 1939.

CONTENTS

| | <u>Page</u> |
|---|-----------------------|
| General ----- | 1 |
| Forest Economics | |
| Forest Survey ----- | 3 |
| Forest Taxation and Insurance ----- | 8 |
| New Public Domain ----- | 9 |
| Private Forestry ----- | 12 |
| Range Economics ----- | 13 |
| Forest Management Research | |
| Forest Fire Protection ----- | 15 |
| ✓ Forest Genetics ----- | 20 <i>typed - 8-8</i> |
| Mensuration ----- | 22 |
| Regeneration ----- | 25 |
| Silviculture ----- | 36 |
| Forest Products | |
| Forest Products Statistics ----- | 45 |
| Timber Harvesting and Conversion ----- | 45 |
| Forest and Range Influences | |
| Flood Control Surveys ----- | 47 |
| Influence of Natural Vegetation on Streamflow ----- | 52 |
| Stabilization of Soils ----- | 62 |
| Range Research | |
| Artificial Revegetation ----- | 64 |
| Grazing Management ----- | 65 |
| Range Plants ----- | 78 |
| Cooperating Bureau Projects | |
| Biology ----- | 79 |
| Entomology ----- | 80 |
| Pathology ----- | 80 |
| Comments ----- | 82 |
| Publications | |
| Manuscripts ----- | 83 |
| Technical Notes ----- | 85 |
| Mineographed Research Notes ----- | 86 |
| In Print ----- | 86 |

GENERAL

Allegheny

Cooperation. Several meetings were held with representatives of the University of Pennsylvania, the Pennsylvania Forestry Association, and the Pennsylvania Department of Forests and Waters, to determine ways and means to continue studies concerning Community Forests, started by the Department of Forests and Waters and later continued as graduate studies in the Division of State and Local Government at the University. A wholesome interest in this phase of study from the local government angle presents a cooperative approach which may be greatly worth while.

Intermountain

Personnel. Mr. Cleve Milligan, for several years connected with the Regional Office of Engineering, was added to the Floods supervision staff on May 1, to handle the hydrological aspects of the preliminary examinations and reports, and to serve in an advisory and supervisory capacity on hydrological matters on detailed survey work.

Mr. H. H. Price, District Ranger on the Cache National Forest, was added to the Floods supervision staff on June 1, responsible for the plant-soils relationship aspects of the preliminary examination and report program, and to assist in detailed surveys.

Lake States

Meetings. The annual investigative meeting held in St. Paul June 1 and 2 was attended by Regional Forester Price, eight representatives of the Regional Office, and two Supervisors. The following points of mutual interest were brought out in the ensuing discussion:

1. Reforestation.

a. Greater care is needed to maintain the rapidly increasing number of plantations on various sites and geographic localities.

b. The area of mixed plantations should be increased to avoid serious losses due to fire, insects, and disease.

2. Timber management.

a. An aggressive extension program is needed to acquaint the private and State foresters with the results of our studies in timber management

b. Information is needed on the management of the oak types which have been completely neglected to date.

3. Economics.

a. Because the division between research and extension work in land-use studies, surveys, farm forestry, and other economic projects is rather hazy, there is a vital need for a closer cooperation between the Station and Region by means of periodic conferences and the prompt exchange of information.

b. Greater emphasis is needed on research and extension work in the utilization of forest products.

4. The work of the Station and the Region in forest biology should be synchronized by regular conferences.

Personnel. The organizing committee of the 7th International Botanical Congress to be held in Stockholm in 1940 has appointed Raphael Zon vice president of the Section for Experimental Ecology.

Southern

Investigative Committee Meeting. Representatives of the Southern and Appalachian Forest Experiment Stations and Region 8 met in Atlanta, April 5 and 6, to discuss research projects in progress and proposed for the future. The meeting differed from previous meetings in that the two Stations met jointly with the Region, and also in that one subject or project, selected in advance, was given primary attention and considered in detail. Discussion of other research projects was not intended to be complete and was confined largely to problems of particular current interest to the Region. The project selected for primary attention was fire research, and the first day was devoted to presentation of the Region's needs and to consideration of current and proposed research. It was agreed that studies of the effects of fire on timber and water resources are of highest priority. On the second day, problems of timber, range, and wildlife management were briefly considered. On both days committees were assigned to summarize the conclusions of the meeting in reports which were read to the group and modified as necessary.

FOREST ECONOMICS

FOREST SURVEY

Appalachian

Inventory. The tabulations of area and volume for the mountain unit of North Carolina have been completed. Some of the findings follow:

Land classification

| | <u>Acres</u> | <u>Percent</u> |
|---------------------|--------------|----------------|
| Forest area | 3,596,800 | 66.7 |
| Non-forest areas | | |
| Agricultural land | 1,517,500 | 28.2 |
| Abandoned crop land | 120,700 | 2.2 |
| Other non-forest | 158,200 | 2.9 |
| Total | 5,393,200 | 100.0 |

(Great Smokey Mountain National Park not included.)

Distribution of board foot volume by diameter classes

| <u>Diameter group</u> | <u>Softwoods</u> | | <u>Hardwoods</u> | |
|-----------------------|-------------------|----------------|-------------------|----------------|
| (Inches) | <u>M. bd. ft.</u> | <u>Percent</u> | <u>M. bd. ft.</u> | <u>Percent</u> |
| 10-12 | 854,700 | 41.0 | 124,300* | 4.1 |
| 14-18 | 733,700 | 35.1 | 1,605,600 | 53.1 |
| 20-24 | 250,200 | 12.0 | 776,800 | 25.7 |
| 26-over | 248,800 | 11.9 | 515,900 | 17.1 |
| | 2,087,400 | 100.0 | 3,022,600 | 100.0 |

*Only yellow poplar, baswood, cherry ash, and walnut considered sawlog size at 12 inches; other hardwoods at 14 inches.

Of the total stand, two-fifths is softwood, and three-fifths hardwoods, with pine and oak predominating respectively.

Depletion. Census returns of lumber production for 1938 have been received from approximately 40 percent of the 3,200 sawmills in North Carolina. A field check of delinquent mills numbering about 1900 has been started in order to obtain complete coverage for the state. This gives an idea of the size of the task in initiating census cooperation in the cost.

California

Reports

With 19 Vegetation Type Map quadrangles now published and 2 more rapidly nearing completion, it is felt that the time is ripe to release them for distribution. Consequently, a portion of our map supply is being turned over to the University of California under the terms of our general cooperative agreement. These will be placed on sale by the University Press at a price of \$1 per copy and the receipts, less a small handling and mailing charge per map, deposited in a cooperative fund to be used for defraying printing costs of additional quadrangles. We are confident that this arrangement will be the means of speeding up our publication program considerably, thereby enabling us to fulfill our obligation of making the type maps available as rapidly as possible. To give this matter wide publicity, a circular briefly describing the maps and telling how they may be obtained, is now being prepared for distribution.

Another step in making the data we have been collecting available for use while they are still comparatively fresh is marked by the completion of our Forest Survey Release No. 1, "The Vegetation Types and Forest Conditions of the Santa Cruz Mts. Unit." This report covers San Mateo, Santa Cruz, and western Santa Clara Counties, which includes the southern end of the commercial redwood belt. Its purpose is to present a general picture of the vegetation resource by county units as far as field work to date will permit. Later on, when the other phases of the Survey are carried out, the picture will be completed, but in the meantime we will be in a position to satisfy the frequent requests for just such information as has been presented. Similar reports for other sections of the State already mapped will be issued as rapidly as other duties permit.

Lake States

Reports

Maps. Bids are being let for a colored lithograph map of the Upper Peninsula of Michigan. This map will show principal farm and forest types for the 10-million-acre unit.

Requirements

Forest Industries. Zon and White conferred with the Industrial Committee of the Minnesota State Planning Board early in May and presented Survey statistics on forest industries. Contrary to common belief, employment in forest industries was fairly well sustained in Minnesota until the recent depression. Almost as many men were employed in 1929 as in 1899, when saw milling was at its peak. Wood processing is carried farther now and requires more labor per unit of raw material.

Northern Rocky Mountain

Reports

With the statistical information for northern Idaho approaching completion, the northern Idaho forest resource report, which will contain a complete summary and analysis of the factual data relating to the resource and problems affecting its proper utilization, is now being written.

Contrasted with the more complete utilization in most of the older forest regions, in northern Idaho along with the rest of the Inland Empire forest managers are confronted with the fact that for the most part only their white pine, ponderosa pine, and cedar can be logged at a profit. Two-thirds of the sawtimber resource of the Inland Empire, however, is of other species and for that reason the hope for better utilization practice very closely links the possibility of these species achieving greater value.

A recently completed requirements study reveals that the Inland Empire is able to consume only a fraction of the lumber it produces and that it depends upon outside markets which are principally east of the Mississippi. In competing with other regions for a place in these markets, the Inland Empire is in a poor position because of its economic remoteness. For example, from Hattiesburg, Mississippi, common boards of longleaf pine must bear about \$10.80 freight to Chicago per thousand board feet, whereas larch-Douglas fir boards from Spokane, Washington to the same destination bear a freight of \$15.84. The Pacific Coast region is likewise economically closer to much of the eastern market because of low cost water transportation. However, even to the inland markets where water transportation is no factor, Douglas fir producers on the coast can compete successfully because of production costs which are over \$4 less than the pine region, or sufficient to offset the somewhat higher freight costs.

Ponderosa pine and white pine are able to surmount this disadvantage because of their high quality; however, the secondary species having nothing to offer in the way of extra utility must compete on the same or slightly lower level than coast fir and southern pine. An attempt has been made to reduce the competitive positions to a numerical basis considering production costs and transportation charges together. To the composite market of New York City, Pittsburg and Chicago, coast fir was found to have competitive advantage of \$4.42 and longleaf pine an advantage of \$3.89 over larch and Douglas fir from the Inland Empire.

The full significance of this relationship as far as the future of the secondary species in the Inland Empire is concerned depends upon the extent and productive capacity of the resource of other regions. If the future productive capacity of the Nation's forests should exceed the requirements for timber products, a possible result might be the continued unmarketability of two-thirds of the resource in the Inland Empire.

Pacific Northwest

Inventory

Revised Inventory Data. Completion of the reinventories continue to disclose with monotonous regularity the unsatisfactory restocking of the older cut-over lands in the Douglas fir region. In Pierce County the area of nonrestocked cut-over land doubled between the 1933 and 1938 inventories. Nearly half the area clear cut between 1920 and 1930 had failed to restock at all by 1938. Slightly relieving this melancholy prospect was the restocking in the last 5 years of approximately one-quarter of the lands cut over prior to 1920 and not restocked in 1933. This slow rate of progress, however, indicates the probable loss of at least three or four decades of growth on a considerable proportion of the clear-cut area with the prospect of a sizable area of land that will never restock naturally.

Volume depletion in Pierce County amounted to slightly more than 2 billion board feet in the 5-year period, practically all in private ownership. The quantity of private old-growth Douglas fir decreased nearly 30 percent during that period.

Reports

First draft of the manuscript of a report giving the results of a supplemental analysis of the pine volume data has been completed. This report, which will be published as an issue of Forest Research Notes, presents in textual, tabular, and graphic form the average stand per acre of the various saw-timber types of survey unit,

the distribution by diameter class of the important pine saw-timber types, and the average volume in residual stands of selectively cut pine stands.

Analysis of volume distribution by diameter class in type 20, ponderosa pine stands more than 22 inches d.b.h. and containing 50 to 80 percent pine, and type 20.5, ponderosa pine stands more than 22 inches d.b.h. and containing 80 percent or more pine, shows that removal of 40 percent of the stand volume would take all trees 32 inches d.b.h. and larger in eastern Oregon and all trees 30 inches d.b.h. and larger in eastern Washington in both types if based on size alone.

Southern

Reports

Twelve reports in various stages of completion engaged the attention of the Forest Survey during April and May. One Survey release, "Forest Resources of Northwest Louisiana," was duplicated and sent out.

Eldredge addressed the Southern Pulp and Paper Club at Savannah on "What are we going to do with our Hardwoods?" which has since been issued as Occasional Paper No. 82. A paper on "Forests in the Economy of the South," by Eldredge prepared for inclusion in the Souvenir Program of the Annual Southern Paper Festival has been issued as Occasional Paper No. 83. Eldredge made two more trips into Georgia, one to Atlanta to attend a meeting of the Regional Committee considering the proposed National Resources Committee Report, "Tomorrow's Timber - Forest Resources in the Development of the South "; the other to attend the meeting of the Georgia Forestry Association, held May 18-19 at Savannah, Georgia, where he made an address, "Development of Georgia's Forest Wealth." It is planned to include the material in this address in the Georgia State Report, now under preparation.

Inventory

Considerable time was spent cooperating with other agencies. Inventory tables were completed for North Carolina Unit #4 for the Appalachian Forest Experiment Station. Inventory and growth tabulations for an east Texas sustained-yield unit were developed for Region 8, which we also assisted with a growth problem in the Wakulla District. Some tabulating work was carried on for the Commodity Exchange Administration. A proposed publication, "New Forestry Facts about Mississippi," was checked and comments submitted.

Requirements

Plans were perfected for the cooperative field work with U. S. Census Bureau in gathering lumber, lath, and shingle production information in the State of Mississippi for the calendar year 1938. On May 21, Smith and Ward left for the field to carry on this cooperative work.

FOREST TAXATION AND INSURANCE

Pacific Northwest

Forest Taxation

DeVries attended a meeting of the Washington State Board of Education at Spokane on April 5 at which there was organized an official State research agency to study and make recommendations regarding the reorganization of school districts in selected counties.

A statistical study of the operation of the yield tax or reforestation laws of Oregon, Washington, and Idaho is being undertaken. Previously published data on the operation of these laws have been very unsatisfactory, because county, State, and Federal lands not subject to taxation are classified under the special tax law. In some cases public acquisition has been assumed to mean declassification without formal action or without official record, in other cases there is a conscious effort to classify public land and to retain in classification land acquired by a public agency.

The decentralized administration and divided responsibility with regard to these laws had made it necessary to secure the statistical data from several sources. Records in the offices of the State Forester, State Tax Commission, county assessors, and tax collectors, and even records from lumber company offices, have had to be examined to obtain complete statistical information on the operation of these special forest tax laws.

It has been assumed that the chief public advantage of the special forest tax laws would be their effect in keeping cut-over lands on the tax rolls and in private ownership. After nearly 10 years of operation this expected effect has not materialized. Of the gross acreage classified under the reforestation law in Oregon in 10 years, 21 percent has been forfeited for non-payment of taxes and remains in county ownership. (A portion of this was classified

after forfeiture). And, reports from the tax collectors of 12 of the 15 counties containing classified land indicate that from 30 to 88 percent of the remaining private classified lands in those counties is chronically delinquent. Delinquency is more prevalent on lands taxed under the Oregon special forest tax law than on those taxed under the property tax. In Idaho 20 percent of the classified acreage has been removed from the tax roll by deeding to the Federal Government, and in Washington $7\frac{1}{2}$ percent of the classified acreage has been purchased by the State.

Washington and Idaho have had practically no experience in yield tax collection. However, Oregon has collected nearly \$10,000 in yield taxes on timber, mostly in the last 2 or 3 years, and a regular administrative procedure has been developed.

NEW PUBLIC DOMAIN

Lake States

The 1939 Minnesota Legislature, which adjourned April 21, dealt with a number of problems affecting forestry and forest land use. The Interim Forestry Commission, in whose studies the Station participated extensively in 1938, succeeded in securing the enactment of many of its proposals, but was forced to yield to "local pressures" on some of its important recommendations.

Of particularly broad significance is the new law governing control and disposal of tax-forfeited lands. A recent Supreme Court decision had upheld the validity of tax-forfeiture laws enacted in 1935, but existing legislation concerning nonagricultural lands forfeited for taxes was obscure. Under the new law, full responsibility for land classification, appraisals, sales, and leases is vested in the county boards. The State Conservation Department, which formerly held a power of veto over the land classification, will have no voice in the land policy. The State, however, is required to pass on appraisals of timber stumpage and to specify the forestry practices to be followed in cutting of timber. Upon request by the county boards, the Conservation Department is authorized to cooperate in the management of lands classified as conservation lands. The Interim Commission's recommendation that nonagricultural lands be placed gradually under State administration was opposed by both the cutover counties, which wanted to retain local control, and by the southern agricultural counties, which wanted to sidestep the issue of lieu tax payments on State lands.

The Interim Commission's bill for a county rural zoning enabling act was adopted without change. The procedure is modeled closely along the lines of the Wisconsin zoning law, giving township boards a veto power over ordinances drafted by the county board.

Other laws dealing with tax-delinquent and other State lands include: (1) an enabling act giving effect to the constitutional amendment adopted in 1938 authorizing exchanges of trust funds lands, (2) a statute of limitations intended to improve tax titles, (3) an extension to November 1939 of laws authorizing installment payment of delinquent taxes, (4) a law authorizing repurchase of forfeited homesteads for the amount of accumulated back taxes and repurchase of non-homesteads at appraised value.

In the field of forestry legislation, new lands include: (1) authorization of small timber sales (up to \$250) without competitive bidding, (2) establishment of a "State Tree Fund" to be used for purchase of tree planting stock in quantity lots for distribution to farmers through the Extension Service of the University, (3) several minor laws concerning bonds by timber purchases and improvements in railroad fire prevention. All of these laws had been recommended by the Interim Commission. A recommendation for registry of timber in transit on highways as a means of controlling timber trespass was not accepted.

Offsetting the gains in organic legislation in forestry and land use was an 18 percent cut in appropriations for the Forestry Division.

A new interim forestry commission was set up to continue the study of forestry problems during 1939-40. The commission is instructed to pay particular attention to the financial aspects of a forestry program.

Pacific Northwest

The grazing use of cut-over lands now largely involved in long-term tax delinquency came to the front in April and May, particularly in Clatsop County, Oregon. After a 2-year search by representatives of the Bureau of Agricultural Economics, in which this office cooperated, 74,000 acres out of 475,000 acres of forest lands were considered adaptable to grazing use; in this the Station did not entirely concur on the basis that criteria were not available on which to justify this classification. The determinations were based mainly upon soil, topography, cover, and commensurability of adjacent farms. Areas with slopes over 25 percent, or having a spruce-henlock cover, or that had not been seeded to grass promptly after logging and burning, were usually excluded. The probable time required in getting farmers to

shift from their present types of farming to grazing was not considered. Delays in making the shift may narrow or otherwise affect estimates of areas adaptable to grazing if the hypothesis is sound that satisfactory sods cannot be established unless the ground is seeded promptly after logging and slash burning. But apparently there are some who believe more forest land is adaptable to grazing than recommended as indicated by the following item appearing in The Oregonian, Portland, May 28:

ASTORIA, May 27 (Special)--The Clatsop county land use committee Thursday lashed out critically at a map classifying county lands, compiled after two years' work by J. C. Moore of the federal bureau of agricultural economics.

The committee charged that Moore's map blocking Clatsop lands into areas suitable for forest growth, concurrent forestry and grazing, agriculture and grazing, had limited the area for grazing and restricted possibility for grazing over large areas which the map classified as suitable for permanent forest.

The committee announced it would view the whole area within the next two weeks before making specific recommendations for altering the map.

Some progress was made in writing the New Public Domain report.

As chairman of the Land Resources Division of the Pacific Northwest Regional Planning Commission, Wilson cooperated in organizing and conducting the regional conference at Seattle, which had for its major theme migration and economic opportunity. Opportunities for additional gainful employment in farming, woodwork, grazing, and recreation were among the subjects considered. Proceedings of the conference are to be published by the commission.

On April 20 Wilson spoke before the Portland Farm Hands Club on the subject "Reconciling Forest and Grazing Uses on Logged-Off Lands in Western Oregon."

PRIVATE FORESTRY

Central States

Farm Woodlands

Interpretation of the analyzed data for the northwestern Ohio woodland study progressed somewhat during the present bimonthly period though the major emphasis was necessarily placed upon plans and preparations for the work in Illinois.

A joint agreement was drawn up between the Station and the University of Illinois Agricultural Experiment Station for the prosecution of a farm woodland economic study of five Illinois counties. The present agreement, dated May 1, will expire on April 1, 1940. Under its terms the Station furnishes supervision, supplies, personnel and funds for the job while the Agricultural Experiment Station furnishes certain services and the use of its equipment. This applies to the gathering of data only. The analysis, synthesis and interpretation will be consummated by this Station.

The work started in mid-May with J. A. Putnam, formerly Hardwood Supervisor for the Forest Survey of the South, directly in charge of the work. He is being reinstated in the Forest Service for this purpose. At the end of May about two-thirds of the crew, including the seven Foresters, was on the job or in transit to Illinois.

The Division of Forest Economics loaned Miss Bessie B. Day, its Statistician in the Washington Office, for a ten-day field period in late May and early June to insure a sound design of field procedure. We are assured that the data will be gathered in such a way that valid inferences may be made from the observations recorded.

In mid-June four men trained in agronomy, agricultural economics and engineering will be hired to care for certain aspects of the job which depart too far from the usual Forester's field and experience.

Lake States

Farm Woodlands

Studies made in the Lower Peninsula of Michigan by the Station in cooperation with the Regional Office and the Michigan State College indicate the need for an educational program among the small owners in the management of their woodlands and the cooperative marketing of their forest products.

The owners of 46 percent of the farm woods in Eaton County in the southern portion of the State could realize an immediate financial return by practicing forest management, while only 7 percent of the farm woods are in such poor condition that no returns could be expected during the farmer's lifetime.

At the request of the Extension Service, the Station is participating in land-use planning in Barron County, Wisconsin. This is one of the counties chosen for intensive coordinated planning by local planning committees. Special emphasis is to be given to farm forestry, with several experimental cuttings, growth stimulation projects, and marketing experiments.

Southern

Financial Aspects

Bond made a trip to Washington in April and assisted in developing plans for a study of the effect of the Wages and Hour Law upon the small sawmills of the South. During May Bond and Reynolds assisted Girard in organizing the field work of this study and then collected from the small mills in Louisiana and Arkansas data showing the effect of the law upon costs, selling prices of lumber, stumpage values, and employment. Scott, formerly with the Forest Survey, was employed to contact mills in Texas. Mills in the other southern states are being studied by men from Region 8 and from the Lake City branch station. The study, which was requested by Mr. Silcox, is not concerned with compliance with or enforcement of the Law, but is being made to show the effect of the Law in forestry practices and to determine what effect better forestry practices might have on costs and returns.

RANGE ECONOMICS

Intermountain

Range Budget Calculations of the Probable Financial Results of Range Improvement Resulting From a Lowered Intensity of Use. Range research has produced certain definite results as to what may be expected in the improvement of an overgrazed range through lowering the intensity of use. These results show an increase in the turn-off per animal, and indicate that as ranges improve due to a lower intensity of use, at least a part of the reduction in animal-months of use can be restored, at the same time maintaining the higher turn-off per animal.

An empirical economic analysis of these results of range research indicate that the range improvement and increased livestock productivity brought about by a reduction in the number of livestock on a range, must take place within a brief period of time if private enterprise is to finance this type of range conservation.

A study of the records of a number of range sheep operators who are operating on what is classed as overgrazed range shows that they are now producing a 60 percent lamb crop, and that these lambs sell as feeders, with an average weight of 60 to 65 pounds. After retaining sufficient ewe lambs for maintaining the band, the cash income that may be expected from this operation is about \$3.50 per ewe. The cash outlay required for operating expense, not including interest paid or return on investment, averages about \$3.00 per ewe.

If these operators were to reduce their sheep numbers by one-third as a range conservation measure, their gross income per ewe would probably remain about the same during the first few years of the period required for effective range improvement to occur. The operating costs would, however, amount to \$4.00 or more per ewe. The costs could not be reduced in proportion to a reduction in sheep numbers due to certain fixed costs which have been incurred on the basis of present sheep numbers.

If effective range improvement, as a result of this reduction in rate of use, requires five years, the loss to a one-band range sheep operator would amount to about \$8,000. This calculation on the probable cost of this operation includes the loss of the annual net income of \$750, the \$750 deficit incurred, with interest at 6 percent compounded annually on this \$1,500 annual cost of the reduction in the number of livestock.

If at the end of the 5-year period the improvement of the range would permit one-half of the cut in numbers to be restored, and would result in a substantial improvement in lamb crops and lamb weights, the annual net income will be considerably better than it was originally. The indications are, that where a one-band operation was producing, before range improvement, an annual net of \$750 for the operator, this operation may be made to produce a net of \$1,500. The value of this annuity of \$750, capitalized at 6 percent, is \$12,500. This is \$4,500 greater than the estimated cost of this conservation operation.

The prospects of realizing this gain appear, however, uncertain and remote to the ranch operator even when the period of deferment is as short as 5 years. The ranch operator is not likely to finance this type of range conservation on his own incentive unless it can be demonstrated that something can be realized on the operation after a very short period of deferment, probably only two or three years.

The cost of a continued decline in the productivity of an overused range might be included in an evaluation of the costs and benefits of improving an overgrazed range by a lower intensity of use. This is likely to be a less tangible item in the calculation of the ranch operator than the cost and value of range improvement.

FOREST MANAGEMENT RESEARCH

FOREST FIRE PROTECTION

California

Behavior

Analysis has been completed of the observations of last summer on moisture content and volume of green foliage in typical brushfields of northern California. Measurements of these two characteristics on two common brush species, manzanita and snowbrush, were regularly made over a period of six months. The moisture content of both kinds of brush varied measurably throughout the day, being normally 4 to 8 percent lower at 2 p.m. than at 8 a.m., or late afternoon. During the fire season, variations in moisture content of more than 40 percent were found in the green leaves of both manzanita and snowbrush. These variations were related to recognizable stages of growth which are expected later to form the basis for a field method of estimating moisture content of such green fuel.

In general there were about twice as many leaves on the brush during the height of the growing season as in the spring or in the fall. It is planned to study the effect of this variation upon wind intensity along the ground and upon moisture content of the litter.

Central

Use of Chemicals for Firebreak Maintenance. An analysis of the effect of soil characteristics upon the toxicity of chemicals to annual and perennial herbs has been partially completed. For this analysis the Station's data on forest soils of the Sierra Nevada are being combined with similar data on agricultural and other soils obtained by the California Agricultural

Experiment Station. Clay content and soil acidity appear to be the two most important soil characteristics influencing the toxicity of the several chemicals investigated.

Fire Danger Rating. Adaptability of the fire danger rating system of Region 5 to conditions has been increased by the introduction of a classification of all danger rating areas throughout the State into 4 groups, each group representing a different weather normal. Geographical extent of the State and wide variations in climate have made this modification of the danger rating system desirable.

It was reasoned that, through forces operating in the past, each area was approximately financed for its normal or most frequent degree of fire danger. These normal danger conditions are known to be higher on some areas than on others. From a study of past weather records all areas were therefore sorted, according to normal danger level, into four general groups. For each of these groups the requirements of different classes of organization were expressed in terms of fire load index, which is defined as the sum of lightning and man-caused ignition indexes multiplied by the spread index.

Lake States

Control

Danger Meters. Since the danger meters do not include such factors as risk, fuel type, and administrative efficiency, a perfect correlation can hardly be expected. However, further work is necessary to eliminate so far as possible inconsistencies which have shown up in the meters.

A comparison of the danger ratings and the occurrence and behavior of forest fires on the national forests of Region 9 during 1938 follows.

| Danger | #1 | #2 | #3 | #4 | #5 | #6 | #7 |
|--------------------------------|-----------------------|-----|------|------|------|-------|-------|
| | <u>Lake States</u> | | | | | | |
| Percent of days with fire | 5.4 | 4.1 | 11.9 | 20.7 | 28.6 | 42.0 | 82.4 |
| Ave. no. fires per day | .06 | .05 | .14 | .28 | .41 | .82 | 2.00 |
| Size of ave. fire | .3 | 1.1 | 2.9 | 1.8 | 7.3 | *23.4 | 16.3 |
| | <u>Central States</u> | | | | | | |
| Percent of days with fire | 2.1 | 5.7 | 13.5 | 33.0 | 73.3 | 92.5 | 100.0 |
| Ave. no. fires per day | .02 | .08 | .21 | .80 | 3.58 | 7.09 | 7.50 |
| Size of ave. fire | 3.7 | 4.2 | 6.7 | 6.3 | 10.7 | 14.1 | 5.7 |
| * Includes one 2000-acre fire. | | | | | | | |

Northern Rocky Mountain

Control

April and May 1939 produced a combination of fire conditions new to this region since the advent of fire danger measurements. Decided drought and high temperatures prevailed over the western part of the region during the period which normally produces the new growth of annuals and perennials. While soil moisture was not extremely low (planting crews reporting moist south slopes on several forests), vegetative growth was definitely retarded as if by some adverse surface condition rather than lack of soil moisture. Whatever the cause, a few of the early annuals, especially cheat grass, were stunted and began to mature from 2 to 4 weeks earlier than usual. They also failed to cover last year's dead

grasses and woods, leaving the latter far more exposed than usual and therefore far more able to carry fire. Adding to this danger was the occurrence of an all-time low humidity of 4 percent at Missoula on May 12, with similar conditions prevailing throughout western Montana and northern Idaho.

Fire danger measurements at valley bottom stations consequently peaked at class 2.4 to 3.4, a full class above normal for June, a month later. Snow prevailed in the high country, of course, but in the belt below it vegetation had not yet started at all, and in the valley bottoms and on burned-over south slopes the new green growth was exceptionally scanty.

The net result was considerable apprehension by the field force and the regional office, the latter reporting to Washington in a wire given service-wide publicity in the Information Digest of May 17, that "a critical fire season impends. Annuals in lower elevations already are matured and burning brown. South slopes are dry - burn freely." Rains were general in Region One, however, by the time this appeared in print and the several other species of vegetation such as pine grass, yarrow, fern, pearly everlasting, lupin, and all the shrubs have since burst into growth with every indication of a normal to abnormally good crop, especially of the forage plants.

When the 10 western supervisors were asked for their opinions of the accuracy or dependability of the fire-danger ratings, which in this region do not include any allowance for variation from normal vegetative condition, the majority expressed their opinion that the ratings were a little too low. Several believed them to be about right and a few pointed out that this particular May condition was most abnormal as well as minor in comparison with real fire season danger measurement and action.

Two conclusions seem obvious: (1) Vegetative condition is very easy to estimate erroneously, some men giving far too much weight to some one species or some very temporary condition. (2) More research is needed to determine not only the species and site to be observed but also some method of measuring the state of inflammability of each plant.

Pacific Northwest

Control

In order to learn more about the leaching of fuel moisture indicator sticks during their period of use, 101 sticks sent in by the forests at the end of the 1938 season were oven-dried, with the

following results:

| | | | | | | | | | |
|-----|---------|---------|-----|-------|--------|---|------|------|------------------|
| 38 | percent | weighed | 100 | grams | within | + | 0.25 | gram | |
| 82 | " | " | 100 | " | " | + | 0.50 | " | |
| 95 | " | " | 100 | " | " | + | 1.00 | " | |
| 99 | " | " | 100 | " | " | + | 1.00 | " | and -2.00 grams. |
| 100 | " | " | 100 | " | " | + | 1.00 | " | " -2.50 " |

These sticks were prepared to contain an even 100 grams of oven-dry wood (after allowing a margin of 1 gram for initial leaching) in order to facilitate the determination of their moisture content. Thus their weight in grams indicates their moisture content without the need for any computations. The sticks are used for only one season of 3 to 5 months. The above results indicate that the present practice is satisfactory.

It was also found that 68 sticks from localities of low rainfall had an average oven-dry weight at the end of the season of 100.04 grams and 33 sticks from stations of heaviest rainfall had an average weight of 99.41 grams, which shows that rainfall has a significant effect on the amount of leaching.

Southern

Control

A tentative fire danger meter has been developed based on the rate-of-spread data obtained by Osborne and Olsen. This meter is a new departure in that the division into danger classes was made on the basis of the rate-of-spread index. The meter itself, instead of being a slide rule, is a chart of a rate of spread index over wind velocity with a pencil of parallel but not equidistant lines for various fuel moisture contents. On this chart the danger classes are five horizontal bands. Before the meter is released for use it is hoped that a scale of indicator-stick moisture content can be substituted for actual fuel moisture content.

Considerable data have already been taken in an attempt to correlate the moisture contents of a rattan mat and a basswood stick with the actual moisture content in the field.

Analysis of the data accumulated in the study of discovery time in the grassy fuels of the coastal plain showed a significant correlation coefficient when discovery time was correlated with rate of spread and the ratio of actual distance from the fire to the tower, to visibility distance. A joint relationship was found to exist in the data which has made it necessary to use an empirical alinement chart or else to insert extra qualifications in the use of the regression equation.

Damage

A study of the mortality phase of damage has been initiated on the national forests of Mississippi, Louisiana, and Texas. This is the first step toward the ultimate preparation of a standardized method of damage appraisals for use principally by the State fire protection organizations.

FOREST GENETICS

California

The Use of X-rays in the Study of Vigor

In recent years considerable interest has centered around the studies of E. Ashby on the correlation of embryo size and vigor of growth in plants. (Ashby, E. "Studies in the inheritance of physiological characters I." Ann. Bot. 44:457-476. 1930 and Ashby, E. "Hybrid vigor in maize." Amer. Nat. 70:179-181. 1936.)

If a correlation exists between the size of the embryo and the inherent vigor of growth in the pines it will have great significance in breeding work. To test out this hypothesis seeds of sugar pine and Jeffrey pine were fastened to a sheet of paper with cement and an X-ray photograph was made. In the X-ray pictures the embryos are clearly visible and can be measured by various means. (The X-ray dosage needed for a picture is much less than that required to induce genetic changes.) The seeds were then planted individually and the initial measurements will be checked against the growth made by the individual seedlings at various periods.

Segregation

Drought Resistant Forms of Pines. Pines that are endemic in the semi-arid mountain sections of the Southwest are of considerable interest in a tree breeding program, as large areas of our country are relatively dry and suitable trees would be most welcome. Several species and forms of pine are among the trees naturally adapted to the less severe of the semi-arid situations. In California the outstanding forms are ponderosa, pinon, Digger and Coulter pines. Each species has its drawbacks as well as its good points, but careful selection and cross breeding may make possible the combining of the good qualities of two or more of these species. In selecting for this purpose, when drought resistance is of primary importance, these

trees growing in the most unfavorable situations are of peculiar interest. It is here that natural selection is more severe; it is here that the greatest deviation from the so-called "normal" form is found; and it is here that the qualities of resistance to adverse environment are most highly developed.

The inner coast ranges from Carquinez Straits southward, and the cross ranges of southern California furnish such an environment and produce many interesting forms of pines. From Mt. Diablo to the San Fernando Valley the ranges of Digger and Coulter pine overlap in many places, and occasionally ponderosa is found with one or the other. Natural hybrids have been reported several times to the California Forest and Range Experiment Station, but investigation proved them to be aberrant forms in most instances. However, deviation is so far from normal in some cases that a breeding test will be necessary to prove the validity of the species. Some of these forms combine the symmetrical form of Coulter pine with the drought resistant qualities of Digger pine. These qualities, combined with the wood quality of ponderosa, would provide a very desirable tree for chapparral planting. Other trees combine various other qualities indicating the possibility of drawing from these natural sources material for breeding better trees.

Nutrition Studies

The nutritional deficiency experiments with ponderosa pine seedlings were started about a year ago. The purpose of these experiments was to get a better understanding of the interplay of environment and heredity in the development of ponderosa pine. As was expected, the deficiency in phosphorus, nitrogen and potash manifested itself very clearly, especially at the beginning of the second season.

On the other hand, an excellent growth of seedlings in tanks containing very little or no calcium was unexpected. In order to inquire more closely into the problem, a more intensive study of the calcium requirements of ponderosa pine has been started.

Northeastern

Breeding

The unseasonable weather in the early spring of 1939 resulted in delayed blooming of the birches, but almost normal time of blooming in the oaks. Consequently, the birches were worked late in April instead of early in April as they were in 1937, and the oaks were worked during the first week in May. Other genera

reacted in the same manner, and it was therefore necessary to cut down work with the genera of minor priority and also to curtail to a slight extent work with the birch and oak. Pines bloomed normally, and a fair amount of work has been done with these. Work with Betula was finished about the middle of May; work with the oaks was finished about the end of May; work with pines was well under way by the first of June.

Pacific Northwest

Breeding

About 1,000 rooted hybrid poplar plants were out-planted as a continuation of the tests supervised by the Northeastern Station. Half of them were planted on lands of the Crown Willamette Paper Company, on a sandy island in the Columbia River formerly covered with cottonwood; the other half were planted on burned-over hill land at the Cascade Head Experimental Forest. Additional cuttings have been planted at the Nursery of the more promising hybrids, and also, by way of comparison, cuttings of the native northern black cottonwood.

MENSURATION

Allegheny

Stand Studies

Growth analyses for the loblolly pine sustained yield study in Maryland have indicated some important things. Under 10 years of age growth is rapid. Between 10 and 20 years growth is still rapid but has dropped materially, even though a large number of smaller trees have dropped out of the stand. Over 20 years growth is constant, with a tendency to drop between 50 and 60 years. The indications are that early treatment at about 10 years is necessary to maintain rapid growth. Further treatment before 20 years might maintain more rapid growth in the period following.

It was also found that growth on trees for a five year period on all trees which lived five years was greater on the average than growth for the same period on just those trees which were still living at the end of 10 years. The indication here is that mortality includes some of the faster growing trees. Field observation in stands

under 10 years of age have shown definitely diseased trees maintaining very rapid growth. These trees tend to drop out when competition becomes great.

California

Tree Studies

The preliminary redwood volume tables were completed in April and Hallin, with two student assistants, is now in the field taking measurements from trees in outlying areas to determine the range of applicability of these tables. Most of the original measurements were taken in the vicinity of Fort Bragg, Mendocino County, and in the Humboldt Bay area, the two principal redwood lumbering centers. It is planned to take measurements from about 200 additional trees from other parts of the region to determine whether additional tables will be necessary.

The measurements to be taken this year will be from trees cut on small logging operations in the Navarro River drainage in southern Mendocino County and near Crescent City and Klamath in Del Norte County. The tables should also be checked by measurements from Santa Cruz County operations, but this work will have to be postponed until 1940.

Central States

Stand Studies

Progress has been made in the analysis of the black locust data. Site quality curves for this species have been completed which, at 50 years, include a spread from 30 to 90 feet comprising seven 10-foot classes. These curves will be issued as a station note at an early date.

Checking over of computations on the black walnut study verified the relationship, indicated earlier, that gross cubic foot volume is not related to original spacing. Age and site index, on the other hand, are closely related. Site index curves for this species are being issued as a station note.

Pacific Northwest

Stand Studies

Results of the third 5-year measurement made this spring of the Siuslaw permanent sample plots in the Mt. Hobo Douglas fir plantation are summarized in a recent report. In these stands,

established by planting 27 years ago, the volume per acre now averages 3,600 cubic feet or 12,000 board feet, International rule. Although the plots contain, on the average, about one-half of the normal number of trees for a natural stand, the cubic-foot and International rule volumes are much higher and now average 137 and 285 percent of normal, respectively. Early individual tree development has evidently been greatly favored by the uniform and wide spacing. Future measurements promise to reveal the trend of this development and show the duration of the advantage given by ample early spacing which averaged about 8 by 8 feet. In general, the form of the dominant and codominant trees is good, few of them having developed wolf-tree characteristics.

Computation of field data obtained on the time study of pruning operations in the Mt. Hebo Douglas fir plantations was completed and a report summarizing the elements of cost has been prepared. In addition to length of stem cleared, pruning time was found to be related to both diameter and crown class, as shown in the following table:

Pruning Time per Tree, Mt. Hebo Plantation

| Diameter b.h. | Crown Class | |
|------------------|--------------------|--------------------|
| | Dominant | Codominant |
| <u>Inches</u> | <u>Man-minutes</u> | <u>Man-minutes</u> |
| 6 | 4.6 | 4.0 |
| 10 | 6.3 | 4.6 |
| 14 | 7.9 | 5.3 |

To estimate the total time required to prune a tree to the 18-foot level on a continuous operation, an average of 1.7 man-minutes should be added for delay and moving time for each tree, assuming about 85 trees per acre are pruned. On this CCC operation the average cost per tree pruned, based on a wage scale of 25 cents per hour, was about 5 cents, including cost of supervision but excluding cost of transportation, camp overhead charges, and tool depreciation. Additional study is needed to accurately determine the value of such stand improvement.

First remeasurements were made of 5 thinning study plots in Douglas fir at Wind River and of 5 on the Mt. Walker Area on the Olympic National Forest.

Rocky Mountain

Stand Studies

While making a growth and yield study of selectively-cut lodgepole pine, volume measurements were obtained on 252 trees growing in stands that had been cut-over from 6 to 64 years. Volumes of these trees were estimated from a table based upon trees growing in virgin uncut stands and compared to the actual scaled volumes of the trees. The results indicated that the volume table for virgin stands gave aggregate values 8.2 percent too low for the cut-over stands. A further comparison by 1-inch d.b.h. classes showed that the volume table for virgin stands consistently underestimated the volumes of trees growing in selection stands. These results indicate that a separate table is probably necessary in computing volumes of stands that have been cut-over for a number of years. Further studies are necessary to determine the cause of the differences in volume observed between cut-over and uncut stands.

The final field work for the growth and yield study of selectively-cut stands of lodgepole pine will be completed in June. The analysis of data collected during 1937 and 1938 is nearing completion and should be in readiness for the final report early in the fall.

REGENERATION

Appalachian

Planting

Spruce type problem analysis. An analysis of the regeneration problems of the cut-over and burned spruce type of the Southern Appalachians has been completed. Establishment of the experiments will be started this summer and planting of the plots will be done in the spring of 1940.

During the field reconnaissance some rather striking observations regarding the effect of vegetative competition on planted red spruce and red pine were made. The following table shows the relation between the condition of the trees and the types of competition. Both spruce and red pine showed marked damage from competition, especially overtopping. For example, only 20.1 percent

of overtopped spruce trees (2 to 7 years in field) were thrifty, 53.7 percent with only side competition were thrifty, while 75 percent of trees free from competition were thrifty. Overtopped trees were only about 60 percent as tall as trees free from competition.

The intensity of vegetative competition in the spruce type is indicated by the fact that of the 800 representative red spruce trees examined 63 percent were overtopped, 25 percent had side competition only, and 12 percent were free.

Experiments have been designed along the lines indicated by the problem analysis to find some satisfactory methods of coping with the heavy cover.

Relation between vegetative competition and condition of trees

| | Red spruce | | | Red pine | | |
|---|----------------|-----------------------|----------------|----------------|-----------------------|----------------|
| | Overtopped | Side competition only | Free | Overtopped | Side competition only | Free |
| | <u>Percent</u> | <u>Percent</u> | <u>Percent</u> | <u>Percent</u> | <u>Percent</u> | <u>Percent</u> |
| Thrifty | 20.1 | 53.7 | 75.0 | 42.3 | 76.1 | 92.7 |
| Unthrifty | 45.2 | 16.3 | 7.0 | 27.7 | 9.0 | 3.3 |
| Dead | 34.7 | 30.0 | 18.0 | 30.0 | 14.9 | 4.0 |
| Number of trees in each competition class | 502 | 196 | 100 | 184 | 134 | 151 |

California

Planting

A report has just been completed covering results for the first two years in the Burney Spring Study. The summary from the report is quoted below:

"A reforestation experiment with 10,800 stock items was conducted in a typical northern California brush-field between August 1936 and November 1938.

"The principal object was to determine whether or not three methods of partial eradication of manzanita and snowbrush differed significantly in their effects on survival of planting stock. The methods of clearing were: (1) Burning, (2) stripping with trailbuilders, and (3) burning followed by stripping. Clearing was completed in the fall of 1936. Other objectives were to compare Jeffrey pine and ponderosa pine as planting materials, nursery grown 1 - 1 transplants with seedlings from direct seeding, and stock sprayed with a rezyl-strychnine-chloroform rabbit poison with unsprayed stock. Planting was in May 1937. Stratified seed was sown in spots protected from rodents by screens.

"Counts of all living trees and of normally developed trees were made periodically until the end of the second season of growth. Other observations were made of growing season weather, soil moisture, root penetration, height growth, water use by sprayed and unsprayed trees, germination of seed, and causes of damage and mortality.

"The three brush treatments were almost equally favorable for survival as measured by stock alive at the end of the second season. Jeffrey pine and ponderosa pine showed no important differences in response to the treatments. This was true also as between transplants and seedlings and between sprayed and unsprayed stock. Rabbit damage, though prevalent, occasioned small loss of trees, and it appeared that uniformity in survival was attributable chiefly to inappreciable site differences resulting from the brush treatments. Uniformity of germination in seed-spots and restricted range of differences in available soil moisture, as between treatments, supported this deduction.

"Compared in terms of normally developed living trees, the stripping treatment was much the poorest, burning was intermediate, and burning and stripping the best. The differences were attributable to selective rabbit damage, and probably will disappear as soon as brush cover recuperates sufficiently.

"Choice between brush treatments apparently may be based on operating costs and practicability of clearing rather than upon differences in effects on planting stock.

"Jeffrey pine was superior to ponderosa pine in survival, both as transplants and seedlings from direct sowing. The differences were not great enough to justify rejection of ponderosa pine in future planting. Germination of the two species was similar. The two species appeared equally palatable to rabbits.

"Transplants were superior in survival as compared with seedlings from direct seeding. Most of the difference was attributable to failure of germination; seedlings which appeared, endured adverse site conditions as well as transplants during the first two seasons. Control of seed-eating rodents warrants further consideration in order that trials of direct seeding may be made on a practicable scale. With stratified seed testing as high as 60 percent, only five seeds need be sown to the spot. Excessive losses of small transplants suggest importance of grading studies now in progress and, perhaps, more drastic culling, even now. Seedlings appeared more palatable to rabbits than transplants.

"Spraying did not improve survival on the whole, nor of either species or stock. Water use was diminished by spraying until new growth developed. Failure to improve survival may have resulted because site conditions were favorable during periods of establishment. Sprayed and unsprayed stock were injured equally by rabbits, possibly as a result of intermingling poisoned and unpoisoned stock in small quantities near a large rabbit population.

"Observation of the plantation should be continued for a number of years until pressure of the recuperating brush is more pronounced and the stock has had time to grow beyond the reach of rabbits."

Central States

Nursery

Nursery performance during first year for cuttings of 25 clones of cottonwood of northeastern origin was summarized in a mimeographed report by Gruschow. The different clones manifested a highly significant variability in height growth and also a differential susceptibility to insect and fungous attack.

Soil Studies. Auten established two nursery fertilizer projects at each of three nurseries: Chillicothe, Ohio; Vallonia, Indiana; and Licking, Missouri.

Previous investigations have shown that coniferous seedlings respond remarkably to phosphorus fertilizers. This is especially true on soils not previously in conifers. On soil in conifers the preceding year, response to phosphorus is still apparent but not so marked. This striking response of pine seedlings to soluble phosphates in the first year before the soil becomes inoculated with mycorrhiza may be explained possibly on the basis of indirect soil effects.

Experiments at Chillicothe, Ohio, in 1938 on neutral to alkaline soil disclosed a highly significant response of pine height growth to aluminum phosphate and no response to calcium phosphate. Calcium phosphate is less soluble above pH 6.5 than below that point. Iron and aluminum phosphates, however, are more soluble above pH 6.5 and reach a minimum solubility at about pH 4. Any influence in the soil then acting to raise the pH or to liberate ammonia would make iron and aluminum phosphates more soluble. A great many of our light nursery soils have been leached of calcium phosphates and hold their phosphorus supply as iron and aluminum phosphates. Soluble phosphates on such a soil would, of course, be effective. Later when the soil becomes inoculated the response may not be so apparent because a mycorrhiza-phosphate mechanism is established.

The literature is voluminous dealing with the effect of pH in highly buffered media on growth of fungi, but almost wholly lacking in the effect of fungi on pH and minerals in weakly buffered soils. The results of experiments on artificial media with relatively fixed pH are, of course, not applicable to soil.

Pine forests for the most part occur on highly leached soils whose phosphorus is held as iron, aluminum, or organic phosphates. Fungi no doubt play an important role under such conditions. The problem deserves some attention in view of its direct application to the use of fertilizers in the nursery.

Planting

The spring examination of the 1938 pine seed spotting experiment afforded the final data for the first year. The analysis has been completed, and the results of this experiment are being summarized. The performance of six native pines seed-spotted in the rough on a rigorous 4 x 4 foot spacing on both north and south slopes was tested. Field germination differed significantly with species, though with a ranking almost the reverse of the tested germinability. Mortality of germinated seedlings was fairly uniform for all species, averaging for the summer 40 percent and for the fall and winter 9 percent. Catch, specified as the proportion of spots supporting any survivor

one year after seeding, ranged for the 100 spot sampling units from 0 percent to 77 percent. The catch for loblolly pine averaged 38 percent and for white pine 28 percent, equivalent to 1026 and 768 trees per acre. No significant difference between aspects has been brought out by the six plots of this experiment.

Seed Studies

Acorn Study. Kautz completed the analysis of acorn samples and plots taken in Missouri to find out what happens to acorns after they have fallen to the ground. In a manuscript entitled, "Results of Preliminary Studies of Acorns in the Missouri Ozarks," he presents the results of the study in which he found that by October or November over 95 percent of the acorns were already defective as a result of insect damage, animal damage or decay. Insects were found to be responsible for the loss of about 70 percent of the acorn crop. Acorns removed from the plots by animals were found to be composed largely and sometimes wholly of defective acorns. The presence or absence of hogs caused no significant variation in the loss of white and black oak acorns.

Lake States

Seed Studies

During the past fiscal year over 500 seed samples have been tested in the Station's seed laboratory. Over 200 of these were samples tested for the regional nurseries or other agencies; the remainder consisted largely of tests made of seed of lesser-known species being studied for the seed manual.

In connection with the latter tests some rather interesting results have been obtained from storage tests of cottonwood and silver maple seed. Both of these species, which lose their germinability at a rapid rate when kept at ordinary temperatures, showed but an insignificant loss in viability after two months in tightly sealed containers at 41°F. (100 to 96 percent and 97 to 92 percent respectively). Judging from a cutting test made of the same lot of silver maple seed at the end of one year's sealed storage, germination will still run better than 50 percent.

A test made on a sample of two-year old "Chinese elm" seed (*U. pumila*) that had been stored during the second year at 41°F. in a tightly closed can showed 50 percent germination.

The Controlled Opening of Jack Pine Cones. Under ordinary conditions the lopping and scattering of jack pine slash results in the liberation of the seed during the hottest and driest part of the summer. It would be much more desirable for the seed to be

scattered in the spring when prompt germination can be expected, or so late in the fall that the seed will lay over until spring under a protective snow covering.

By cutting the cone-bearing branches at different times during the spring, summer, and fall and fastening them to frames at various heights above the ground, it is hoped that the best time and manner in which to lop and scatter jack pine slash can be determined.

Rocky Mountain

Planting

Winter losses in shelterbelt at experimental range. The beneficial effect dead weeds may have in preventing winter losses in shelterbelt plantations on open range land was revealed by an examination made in May, 1939, of a shelterbelt planted in the spring of 1938 on the Central Plains Experimental Range. This shelterbelt is in two sections. On one section weeds were not artificially removed by cultivation, resulting in a dense stand of Russian thistle (tumbleweeds) adequate to provide protection for the trees. On the other section practically all weeds were removed by hand cultivation in the rows between the trees. The result is that the mortality is lowest, trees are generally more thrifty, and less rabbit damage occurred where weeds were left. The junipers were severely wind burned where they had not at least partial protection by tumbleweeds. One cannot deduce from this that cultivation is harmful, but that it can be overdone and on very exposed sites it would be well to have some annual weeds close to coniferous trees for winter protection.

Southern

General. On April 7, Mr. H. P. Barss, Principal Botanist in the Office of (Agricultural) Experiment Stations at Washington, visited the experimental plantations and nursery beds on the Palustris Experimental Forest, and discussed the Station's seed studies with Wakeley, to acquaint himself with the work being done by the Forest Experiment Stations. He was particularly impressed with the experimental designs used at the Southern Station, with the problem analyses and working plans now in use, and with the dissemination of statistical technique among our staff by means of Washington training details and the inclusion of statistical methodology in our mensuration project. On his part, he contributed a number of valuable leads on stored-food problems of both seed and seedlings, based on his work as a pathologist and physiologist.

The seed laboratory was moved back from the Harrison Experimental Forest to New Orleans April 27, to facilitate computation and report-writing. Testing is over for this fiscal year, and the laboratory equipment has been stored on the Harrison until next fall.

Seed Studies

Moisture content of longleaf pine seed. A special report embodying the results of a study of equilibrium moisture contents of longleaf pine seed was sent to Region 8. The essential part of the report is a chart showing the approximate moisture contents of longleaf pine seed at all humidities from 20° to 90°, and all temperatures from 32° to 78° F. This served Region 8 as a basis for the preparation of specifications for a cold storage seed house at the Stuart Nursery.

Storage of longleaf pine seed. Miss Nelson completed a report on a two-year informal study of storage of longleaf pine seed at two different temperatures and five different initial moisture contents. The essential data are contained in the following table:

Germination percentage of longleaf pine seed after storage in sealed glass jars for indicated periods 1/

| Calculated initial moisture content | Room temperature | | | 38° F. | | |
|--|-------------------|-------------------|-------------------------------|-------------------|-------------------|-------------------------------|
| | 1 year | 2 years | | 1 year | 2 years | |
| | Unstrat- ified | Unstrat- ified | Strat- ified ^{2/} | Unstrat- ified | Unstrat- ified | Strat- ified ^{2/} |
| 22.0 | 0.0 | 0.0 | 0.0 | (12.4 | 1.6 | 0.4) ^{3/} |
| 17.8 | 0.0 | 0.0 | 0.0 | (34.8 | 1.6 | 1.2) ^{3/} |
| 12.6 | 0.0 | 0.0 | 0.0 | (59.6 | 69.2 | 71.6) ^{3/} |
| 9.5 | 0.8 | 0.0 | 0.0 | 56.8 | 76.8 | 70.4 |
| 6.0 | 48.8 | 20.0 | 7.6 | 66.4 | 80.8 | 75.2 |

1/ Germination percentage before samples were dried and stored was 77.3.

2/ Moist, cold stratification in peat moss for 40 days, between removal from storage and initiation of germination test.

3/ Held in sealed jars at room temperature for 8 to 15 days before being placed in refrigerator--hence not strictly comparable with other seed lots held at cold storage.

The original germination percentage was 77.3. An inspection of the above table indicates (1) that for successful storage, even at low temperatures, seed moisture content must be reduced to 12 percent or lower (basis, dry weight of seed); (2) that seed at 6 percent moisture content kept fairly well for one year and still was somewhat viable after 2 years of office air temperature storage, a storage environment which usually results in complete loss of viability after only a few months; and (3) that treatment of longleaf seed by moist, cold stratification prior to beginning the germination tests did not increase the total percentage.

Nursery

Nursery soil amendments. Muntz completed the office report on the first-year results of the soil amendment study laid out at the Stuart Forest Nursery in 1937. The soil of the Stuart Forest Nursery, in central Louisiana, is a compact silt loam, slow to absorb water and to become workable again after rain, and tending to crust badly when dry. Since experience indicated the need for amendments other than commercial fertilizer, nine (and an untreated check) were tested in replicated plots sown to longleaf, slash, loblolly, and shortleaf pine.

The amendments tried were compost (grass and pine needles piled with topsoil for 18 months); fertile, sandy topsoil; pure, fine quartz sand; acid peat; chopped longleaf pine needles; chopped rice straw; finely ground charcoal; shredded bagasse (crushed sugar cane); and relatively fresh hardwood sawdust. At the end of the growing season, the top length, stem diameter, root length, root extent, green weight, and plantable percentage were averaged for each species and treatment.

Compost, in general, proved markedly superior to every other treatment, and was significantly better than the untreated check on the basis of every variable measured. The relationship of all treatments to the untreated check is summarized in the following table:

Summary of all variables in terms of significant superiority or inferiority to the check

| Treatment | Variables evaluated | | | | | |
|--------------|---------------------|---------------|-------------|-------------|--------------|----------------|
| | Top length | Stem diameter | Root length | Root extent | Green weight | Plant. percent |
| Compost | Good | Good | Good | Good | Good | Good |
| Topsoil | Good | -- | -- | Good | -- | Good |
| Sand | -- | -- | Good | Good | -- | -- |
| Acid peat | -- | -- | Good | -- | -- | -- |
| Pine needles | -- | -- | -- | -- | -- | -- |
| Rice straw | -- | -- | -- | -- | -- | -- |
| Charcoal | -- | -- | -- | -- | -- | -- |
| Bagasse | -- | -- | -- | -- | Bad | -- |
| Saw dust | Bad | Bad | -- | Bad | Bad | Bad |

Good = Significantly superior to check.

Bad = Significantly inferior to check.

Blank = Not significantly different.

Supplementary observations showed: Retarded germination and early mortality with sand, sawdust, and bagasse; crooked root systems with chopped pine needles and rice straw; increased water absorption by the soil with most amendments; excessive surface drying with sand, sawdust, and bagasse; reduced crusting with all amendments; and easier lifting with sand, acid peat, compost, and sawdust.

Under the conditions described, compost seems to offer great possibilities; some of the other amendments may be useful in special cases.

Southwestern

Planting

Recent examination of Douglas fir seed spots verifies earlier deductions. A previous report¹ presented the results of a Douglas fir seed spotting experiment that involved the sowing of Douglas fir seed in prepared and unprepared spots half of each of which were protected with hardware cloth screens and the other half left unprotected.

¹Bi-monthly report, October 1938, page 50.

The seed was sown in October 1937 at the rate of 10 seeds per spot. On the basis of the seedling count made on August 26, 1938, the following deductions were made:

1. That soil preparation helps materially to insure a high percentage of successful spots.

2. That there is no advantage gained in seed spot preparation unless the spots are protected.

3. That without some means of protection the percentage of successful spots is likely to be too small to warrant the use of this method of artificial regeneration.

On May 7, 1939, the seed spots were again examined to determine the extent of losses since the previous examination. The results are shown in table 1. To enable comparison, the results of the previous examination are also given. Attention is again called to the method of expressing the results; namely, in percentages of spots having different numbers of seedlings such as one or more, two or more, etc. As will be noted, the percentages of spots containing seedlings have become considerably reduced under all conditions. Nevertheless, the former relationship between results of prepared and unprepared spots and between protected and unprotected spots remain essentially the same, thus verifying the earlier deductions. Determinations of the causes of seedling losses showed that considerable numbers of seedlings were killed as the result of frost heaving. It is noted that less of this occurred in the screened spots than in those left unprotected, indicating that the screens exert some beneficial influence in this respect. It was also noted that the seedlings under screens had a healthier color (blue-green) than those in the unprotected spots, many of the latter having a somewhat yellow color and dry appearance at the time of examination. Most of the mortality was noted as being due to seedlings "drying up." This was found to be true especially in spots in which the seedlings had been insufficiently hardened to withstand the late fall and early winter drought and to some extent in spots in which the seedlings had come up in groups, indicating that competition was involved. Likewise, seedlings in spots located under the canopy of old trees and in the dense shade of shrubs died because of not being sufficiently well developed. These findings are in accord with those of previous experiments conducted to determine the factors influencing natural reproduction.

Table 1. Survival of Douglas fir seedlings in screened and unprotected and in prepared and unprepared spots. (100 spots under each condition. Total 400 spots.)

| Seedlings per spot No. | Screened spots | | Unprotected spots | |
|---------------------------------------|----------------|----------------|-------------------|----------------|
| | Prepared | Unprepared | Prepared | Unprepared |
| | <u>Percent</u> | <u>Percent</u> | <u>Percent</u> | <u>Percent</u> |
| <u>Survival as of August 26, 1938</u> | | | | |
| 0 | 9 | 10 | 44 | 43 |
| 1 + | 91 | 90 | 56 | 57 |
| 2 + | 82 | 73 | 29 | 33 |
| 3 + | 72 | 58 | 15 | 16 |
| 4 + | 61 | 45 | 9 | 8 |
| 5 + | 56 | 51 | 5 | 4 |
| <u>Survival as of May 7, 1939</u> | | | | |
| 0 | 14 | 23 | 63 | 72 |
| 1 + | 86 | 77 | 37 | 28 |
| 2 + | 75 | 57 | 14 | 17 |
| 3 + | 64 | 46 | 9 | 9 |
| 4 + | 53 | 37 | 5 | 2 |
| 5 + | 42 | 21 | 1 | 2 |

Since the area had been thoroughly treated with poison during the past season, no losses due to rodents were expected; and results confirmed this prediction. Losses in the unprotected seed spots during the past fall and winter are, therefore, as in the screened spots, all associated with unfavorable environmental factors.

SILVICULTURE

Appalachian

Stand Improvement

Crop Tree Cleanings. A study of the results of C.C.C. timber stand improvement, begun last fall, is to be completed before the end of the fiscal year. Analyses of data on the dominance of crop trees

five years after treatment indicate that the methods used were satisfactory. Treated areas on the national forests from West Virginia to Georgia were examined. Of 240 white pine crop trees measured, 74 percent are free to grow now (five years after treatment) and if the growth of sprouts and crop trees continues at the present rate, 48 percent will still be free 10 years after the treatment. At present the crop trees average 20 feet in height and the surrounding sprouts are about one-half as high.

Of 204 yellow poplars, 88 percent are free now, and it is estimated that 78 percent will be free at the end of 10 years following treatment. These crop trees average 30 feet in height now, while the sprouts surrounding them average 10 feet.

California

Harvest Cuttings

A problem analysis for silvicultural investigations in the redwood region has just been completed by Person. The proposed research program places major emphasis on problems involved in harvesting the trees which will now yield a profit without unnecessary damage to the remainder of the stand. This emphasis is justified because the 900,000 acres of virgin redwood, which, at the current rate of depletion will last for 60 or 70 years, are probably sufficient to supply present demands indefinitely if the productivity of these lands can be maintained; and because it is much less difficult and less costly to maintain the productivity of virgin redwood areas by means of tree selection cutting than to restore clear-cut areas which are badly understocked. Tree selection is proposed as a basis for management because redwood and most of its associates are tolerant species which reproduce best under partial shade and produce the largest yield of quality lumber from dense stands.

It is obviously wasteful to destroy by clear cutting and broadcast burning some 10 to 25 thousand board feet of timber per acre in trees up to 36 inches in diameter and 300 to 400 years of age which now have little or no net conversion value. It is particularly undesirable in the case of a timber type such as redwood which is naturally an all-aged forest ideally suited to selective treatment.

Central States

Silvics

Chestnut Oak Regeneration. The ten-year remeasurement of the chestnut oak regeneration plots on the Clark County State Forest were initiated during May by McGuire. Response of seedlings on the clear-cut plots was striking, showing many individual seedlings attained a height of 20 feet on portions of the plots where sprout competition had been removed.

Sprouting Study. The data have been worked up and the report is in the process of being written for the study on sprouting and possible ways of reducing sprouting of inferior hardwoods of the Missouri Ozarks. Of the three treatments used, felling, notch-girdling and peel-girdling, the latter seems to be the most effective in reducing the percent of trees sprouting, number, length, and growth of sprouts, and length of the main sprouts. Treatment performed during the hot, dry summer months was followed by the least amount of sprouting. Height and intensity of treatment apparently were not significant.

Lake States

Silvics

Black Spruce as a Fire Species. "The Role of Forest Fires in the Natural Reproduction of Black Spruce" was the title of a paper presented at the annual meeting of the Minnesota Academy of Science held in St. Paul, April 25, by R. K. LeBarron.

The characteristics that permit black spruce, generally considered a swamp species, to frequently become established in pure stands following fire are:

1. The species produces some seed almost every year and these seeds are slowly disseminated over a period of several years.
2. These persistent cones are borne in a dense cluster near the top of the tree where they are not apt to be harmed even by a severe crown fire. Thus large quantities of seed are liberated at a time when the vegetation and litter that normally interfere with the establishment of seedlings have been destroyed.

Northeastern

Silvics

Restoration of Hurricane Damage: Two rehabilitation crews left for the field early in May to remeasure permanent sample plots damaged by the hurricane of last September. An effort will be made to restore to as full measure as possible the research value of those plots not damaged beyond repair, and to retrieve all possible values from plots scheduled for abandonment because of excessive damage. Several men from Region 7 were transferred to the Station to assist in this work.

Work was started in Connecticut as soon as back roads were passable and will progress northward as the season advances. The program also calls for the rehabilitation of grid and cruise plot systems on the Gale River and Bartlett Experimental Forests, certain sections of which suffered severe damage.

The principal task of the crew is to check, remeasure, and clean up the plots worth retaining. The clean-up job consists mainly of removing trees which are leaning into trees comprising the plot or into border trees which endanger plot trees. Detailed records are being made of the character and extent of damage to individual trees.

Soil Survey Conference: At the request of the Chief of the Division of Soil Surveys in the Bureau of Plant Industry and Director of the Northeastern Forest Experiment Station, a group of foresters and soils men met during the first week of June for a discussion of the adaptation of soil survey practices to the needs of forest management. The conference was held at the Harvard Forest, Petersham, Mass., with subsequent field trips to areas in southern New Hampshire and Maine where soil survey parties are in the field, and to the Fox Demonstration Forest of the State of New Hampshire, and the Massabesic Experimental Forest at Alfred, Maine.

The trend of current research in forest soils was presented by a number of speakers at the conference in order that the soil survey staff might know the problems which appear most significant to foresters. A committee was appointed to prepare for the Journal of Agricultural Research an authoritative set of definitions to be used in the classification of humus types. It was agreed that humus types should be considered along with other factors in classifying forest soils, and where well defined the humus type may be a major influence in determining soil types.

The discussion brought out clearly the necessity for differentiating between taxonomic units in describing soil types and classification of soils for mapping. The consensus of opinion appeared to be that in forested areas the soil complexes which might involve two or more of the usually defined soil series should be the basis for mapping. The soil complexes should be defined in a way which will permit ready determination of the boundaries in the field, but the intensity of mapping and of classification might vary with local conditions. The report would give a description of the soil types which were included in each of the complexes mapped and would also give criteria for distinguishing the individual series or types on the ground. An intensive map on a relatively large scale would be prepared for a readily accessible sample of each soil complex. This sample area would be permanently staked out and would show the pattern in which the individual types occurred. It would serve as a demonstration area for foresters and others interested in the interpretation of the soil maps.

This conference was particularly significant in that it was the first time that foresters, soils research, and soil survey men have gotten together for joint discussion of problems of mutual interest.

Stand Improvement

Pruning in Relation to Blister Rust on White Pine: Although many foresters believe that the sole purpose of pruning is to improve the quality of the pruned tree for lumber purposes, evidence at hand reveals that pruning may be a means of controlling blister rust on white pine.

Five years prior to the last remeasurement of a white pine sample plot in an area heavily infected with rust, selected crop trees on the plot were pruned to a height of 8-12 feet. This plot was in a plantation fifteen years of age whose average breast high diameter was 3.6 inches. At the time of pruning there was little rust on the plot. Five years later, as shown in the accompanying table, none of the pruned trees were rusted while fifty percent of the unpruned trees were infected. Most of this infection, however, appeared to be confined to the lower limbs, very few stem lesions being evident.

The Effect of Pruning upon Blister
Rust Infection of the Northern White Pine

| | Pruned Number | Not Pruned Number | Total Trees Number |
|-------------------|------------------|----------------------|-----------------------|
| Rusted | 0 | 111 | 111 |
| Not Rusted | 59 | 109 | 168 |
| Total | 59 | 220 | 279 |
| Percent Rusted | 0 | 50.5 | 39.8 |

Pacific Northwest

Harvest Cuttings

Isaac, with two field assistants, has been making the periodic examination of the series of permanent sample plots in selectively logged areas in the Douglas fir region. Two new plots were established on the Mt. Hood Forest and still others are contemplated. On the Siltcoos Lake area in practically pure spruce which was cut in 1935 and 1936, a recut was made during the past year taking out additional scattered high value trees. An examination of their stumps indicated that where the tree had logging injury, as many of them did, decay and borer damage was already evident.

A recheck of the 50 miles of permanent transect which samples the 35,000 acres of maturity selection system cutting on the Malheur National Forest was begun. This is going to give valuable data on mortality ratios and growth for various tree classes, as well as quality increment, under the two variations in marking that have been employed. The 400 permanent growth plots on this transect are closely tied in to the economic logging studies made on this working circle two and three years ago. Since Kolbe's return from his 3-months detail in Washington, he has spent most of his time analyzing the Pringle Falls methods of cutting plot data and the physical factors measurements which have been taken there since 1936.

Southern

Stand Improvement

Effect of pruning on the growth of longleaf pine. Remeasurements during the past winter of a pruning experiment in longleaf pine have recently been summarized. The average 3-year growth in d.b.h. and in total height of the 1303 trees is given below for two different classifications of degree of pruning. When the study was established in 1936, the trees were 3 to 8 inches in d.b.h.; and all are open-grown in an understocked stand. The growth during the past 3 years shows no appreciable or consistent relationship to the original 1-inch d.b.h. classes. The summaries show that pruning up to 50 percent of the crown length, or to 60 percent of the total height, has resulted so far in a loss of less than 1 year's d.b.h. growth. Even the most severe pruning has resulted so far in a loss of less than 2 years' d.b.h. growth, but the eventual loss of growth in this class will probably be very much greater. There is no apparent reason for the greater d.b.h. growth either in several classes of very light pruning than in the no-pruning or check classes, or in the 91 - 100 percent pruning than in the 81 - 90 percent group. Height growth has been slightly greater for the heavier degrees of pruning, but the data were not tested for statistical significance.

Effect of pruning on the D.B.H. growth of open-grown longleaf pine saplings

| Reduction in crown length | No. trees | Average D.B.H. growth in 3 years | | Proportion of total height to which pruning was carried | No. trees | Average D.B.H. growth in 3 years | |
|---------------------------------|--------------|--|----------------|---|--------------|--|----------------|
| <u>Percent</u> | | <u>Inches</u> | <u>Percent</u> | <u>Percent</u> | | <u>Inches</u> | <u>Percent</u> |
| 0 | 177 | 1.24 | 100.0 | 0 | 176 | 1.24 | 100.0 |
| 1 - 10 | 159 | 1.36 | 109.7 | 1 - 10 | 0 | | |
| 11 - 20 | 173 | 1.20 | 96.8 | 11 - 20 | 8 | 1.45 | 116.9 |
| 21 - 30 | 201 | 1.12 | 90.3 | 21 - 30 | 102 | 1.51 | 121.8 |
| 31 - 40 | 148 | 1.10 | 88.7 | 31 - 40 | 112 | 1.24 | 100.0 |
| 41 - 50 | 127 | 0.96 | 77.4 | 41 - 50 | 317 | 1.14 | 91.9 |
| 51 - 60 | 114 | 0.73 | 58.9 | 51 - 60 | 197 | 1.05 | 84.7 |
| 61 - 70 | 108 | 0.61 | 49.2 | 61 - 70 | 166 | 0.80 | 64.5 |
| 71 - 80 | 66 | 0.43 | 34.7 | 71 - 80 | 134 | 0.60 | 48.4 |
| 81 - 90 | 14 | 0.33 | 26.6 | 81 - 90 | 74 | 0.39 | 31.5 |
| 91 -100 | 16 | 0.52 | 41.9 | 91 -100 | 17 | 0.51 | 41.1 |

Effect of pruning on the height growth of
open-grown longleaf pine saplings

| Reduction in crown length | No. trees | Average height growth in 3 years | | Proportion of total height to which pruning was carried | No. trees | Average height growth in 3 years | |
|---------------------------------|--------------|--|----------------|---|--------------|--|----------------|
| <u>Percent</u> | | <u>Feet</u> | <u>Percent</u> | <u>Percent</u> | | <u>Feet</u> | <u>Percent</u> |
| 0 | 74 | 6.27 | 100.0 | 0 | 74 | 6.27 | 100.0 |
| 1 - 10 | 45 | 6.22 | 99.2 | 1 - 10 | 0 | | |
| 11 - 20 | 47 | 6.46 | 103.0 | 11 - 20 | 4 | 5.75 | 91.7 |
| 21 - 30 | 50 | 5.71 | 91.1 | 21 - 30 | 21 | 5.90 | 94.1 |
| 31 - 40 | 45 | 6.34 | 101.1 | 31 - 40 | 40 | 6.21 | 99.0 |
| 41 - 50 | 47 | 6.21 | 99.0 | 41 - 50 | 78 | 6.13 | 97.8 |
| 51 - 60 | 40 | 6.86 | 109.4 | 51 - 60 | 58 | 6.46 | 103.0 |
| 61 - 70 | 39 | 6.30 | 100.5 | 61 - 70 | 67 | 6.40 | 102.1 |
| 71 - 80 | 20 | 6.74 | 107.5 | 71 - 80 | 49 | 6.51 | 103.8 |
| 81 - 90 | 3 | 6.87 | 109.6 | 81 - 90 | 18 | 6.59 | 105.1 |
| 91 -100 | 6 | 7.55 | 120.4 | 91 -100 | 7 | 7.54 | 120.3 |

Southwestern

Silvics

Relation of regeneration of Douglas fir cut-over stands to seed supply. In the fall of 1937 a good seed crop of Douglas fir occurred in the Sacramento Mountain region of southern New Mexico. As a basis for determining the amount of seed fall 100, 3 by 3 foot seed traps were randomly distributed over a 5-acre plot laid out within a selectively cut stand. At the same time an equal number of 2.2 by 2.3 foot frames made of 1 by 6 inch boards, with one face covered with No. 2 mesh hardware cloth were placed near the seed traps. The purpose of these frames was to prevent destruction of whatever seed may have fallen within the enclosed areas, thereby affording a basis for determining the resultant numbers of seedlings in relation to amount of seed fall. To prevent undermining by rodents the frames were partly embedded in the forest floor. In October 1938 a careful count of all seedlings within the frames was made. At the same time a count of seedlings was made within 100 unprotected spots selected near the screened frames and each embracing the same amount of area.

Inasmuch as the amount of seed caught in the seed traps varied greatly, it seemed worth while to analyze the seedling data with reference to such variation. This was done by grouping the

seed trap data according to differences of 10 seeds per trap and then computing the average number of seedlings per square foot and per acre. Since the number of seedlings on both the protected and unprotected spots corresponding to each set of traps was known, it was of course possible to determine the percentage of seedlings obtained in relation to amount of seed.

The results of the compilation are shown in table 2. Although the relationship is not wholly consistent, the results indicate that as the seed supply increases the percentage of seedlings obtained decreased. The fact that this relationship obtains for protected as well as for unprotected spots would seem to indicate that it is not primarily due to differences in the disturbing effect of rodents and birds. On the other hand, the much smaller percentage of seedlings obtained in the unprotected spots clearly shows to what extent seedling establishment is prevented by the destructive action of rodents and birds.

Table 2. Douglas fir seedlings obtained in relation to different amounts of seed. (Based on seed caught in seed traps and numbers of seedlings in nearby spots.)

| Seeds per trap | Traps | Seeds per sq.ft. | | Seeds ^a per A. | Screened Frames | | Unprotected Spots | | | |
|----------------------|-------|---------------------|-------|------------------------------|-----------------------|----------------------------------|-----------------------|----------------------------------|-----------------------|----------------------------------|
| | | | | | Seedlings obtained | Seedlings ^b per A. | Seedlings obtained | Seedlings ^b per A. | Seedlings obtained | Seedlings ^b per A. |
| No. | No. | No. | No. | No. | % | % | No. | % | % | No. |
| 1-10 | 15 | 0.80) | 1.33 | 58,000 | 25.0) | 13.8 | 8,000 | 10.8) | 4.9 | 2,800 |
| 11-20 | 22 | 1.69) | | | 10.2) | | | 3.2) | | |
| 21-30 | 18 | 2.72) | 3.23 | 141,000 | 11.0) | 10.7 | 15,100 | 4.5) | 4.7 | 6,600 |
| 31-40 | 14 | 3.88) | | | 10.3) | | | 4.8) | | |
| 41-50 | 15 | 4.81) | 5.21 | 227,000 | 13.3) | 12.8 | 29,100 | 3.6) | 2.7 | 6,100 |
| 51-60 | 6 | 6.19) | | | 11.3) | | | 1.1) | | |
| 61-70 | 5 | 7.18) | 7.63 | 332,000 | 8.9) | 9.2 | 30,500 | 1.1) | 1.3 | 4,300 |
| 71-83 | 3 | 8.37) | | | 9.6) | | | 1.6) | | |
| 109 | 1 | 12.11 | 12.11 | 528,000 | 6.6 | 6.6 | 34,800 | 1.6 | 1.6 | 8,400 |
| 130 | 1 | 14.44 | 14.44 | 629,000 | 6.9 | 6.9 | 43,400 | 1.4 | 1.4 | 8,800 |
| Total & Av.* | 100 | 3.49 | | 152,000 | | 11.2 | 17,000 | | 3.2 | 4,900 |

^aTo nearest 1000

^bTo nearest 100

*Weighted

FOREST PRODUCTS

FOREST PRODUCTS STATISTICS

Northern Rocky Mountain

Census. As the result of a 10-day mop-up trip on which Whitney visited 19 delinquent establishments and obtained their 1938 lumber census reports, the Region One mailing list was cleared by May 15. For the region as a whole (including Montana, northern Idaho, and northeastern Washington) preliminary compilations indicate a total cut of approximately 814,000,000 board feet in 1938 as compared with 1,190,267 board feet in 1937, a decline of nearly 32 percent. As in 1937, the combined cut of Idaho white pine and ponderosa pine for 1938 amounted to approximately 75 percent of the total volume.

Pacific Northwest

Census. Johnson spent about two weeks in the field picking up concerns that had failed to submit reports or whose reports were incomplete. To date 2,029 edited schedules have been forwarded to Washington. It is expected that the census will be completed by the middle of June.

TIMBER HARVESTING AND CONVERSION

Northern Rocky Mountain

Conversion

Intermountain Logging Congress. Bradner represented the station at the first annual meeting of the Intermountain Logging Congress held in Kalispell, April 20 and 21. Two days of discussion were held on a wide range of topics including brush disposal. The attendants were enthusiastic about the meeting and plan a second session in Missoula in 1940.

Madison Conference. Anderson attended the conference of forest products agencies recently held at Madison. Following the conference he visited lumbering operations in the middle west and viewed their utilization and lumbering problems.

Deception Creek Logging Area. Plans are under way to log about 660,000 feet of timber on the Deception Creek Experimental Forest, taking about one-fifth of the volume of white pine per acre in a light cut. The timber to be taken is upper-slope type in which heavy losses have been occurring in recent years.

Pacific Northwest

Conversion

Utilization. Tie production in small mills has always been associated with poor utilization because of very heavy slabbing. During a recent field trip it was noted that many of these mills are now producing a side cut of 2-inch round edge lumber 8 feet in length. This material is shipped to central plants where it is resawn into 8-foot 2x4's. On operations where such is the practice, the waste in slab has been reduced to a very small amount.

Selective Timber Management in Douglas Fir. Further progress was made on the Weyerhaeuser Timber Company's study of selective cutting, with which Brandstrom is keeping in close touch and to which he is giving technical aid and advice as needed. This study covers a 1400-acre area of virgin timber near Mineral Lake, Washington, on which all merchantable trees 26 inches and over in diameter have been tagged, numbered, log-graded, and mapped in place on a large scale map. A detailed analysis of the log-graded trees and preparation of logging plans for various methods of cutting are now under way.

Brandstrom also took an active part as a consultant to the Division of State and Private Forestry and Crown Zellerbach Corporation in a new project involving an economic stand structure analysis of an 11,000-acre area of spruce-hemlock timber near Tillamook, Oregon, -- an area containing about 600 million feet of timber owned by the Crown Zellerbach Corporation. The primary objective of the study is to determine recovery values for various degrees of selective cutting on the basis of which the company in setting up their income tax declarations can claim capital depletion in accordance with the true values removed--all in accordance with present income tax laws as interpreted by Mr. Wohlenberg of the Division of State and Private Forestry. This is the first case study of this particular kind in the Douglas fir region and so will naturally be watched with great interest by all parties concerned.

Plans for collection of field data for this project have been completed. They call for taking some 500 1/8-acre sample plots, on which among other things all merchantable trees 16 inches and over are to be taped, classified, and log-graded, each tree being recorded on an individual tree card.

The log-grade system to be used in this study, following careful field study by Carlson of the Division of State and Private

Forestry, has been patterned after the ponderosa pine log grading system which this Station has sponsored and used for the last several years in connection with logging and milling studies in that region. Accordingly the logs are to be graded in six different grades, based on surface characteristics only, so that they can be identified as readily in the standing tree as in the pond or on the log deck. A departure from the pine system, however, is the breakdown of grade 1 and 2 logs into three subgrades that distinguish between shallow, medium, and deep clears--a variable which is of very great importance in this region.

Another departure from the pine studies is that log values in the present study are to be based on the log market instead of following the logs through the mill. This calls for making a careful correlation between the woods grades mentioned above and the commercial water grades and between gross woods scale and net water scale. For this purpose a large number of logs in the company's rafts will be carefully graded on the basis of both systems, and scaled both on the basis of net and gross scale until reliable correlations are found.

FOREST AND RANGE INFLUENCES

FLOOD CONTROL SURVEYS

Allegheny

Preliminary Examinations

The preliminary examination report of the Passaic River, N. J., watershed has been approved by the Field Working Committee and will shortly be transmitted to the Flood Coordinating Committee in Washington. A preliminary report of flood conditions on the Pequest River, N. J., is well advanced, and Mesavage hopes to complete his writing within the next month. The problem in this watershed involves the distinction between drainage and flood control and may serve to establish a general policy in this respect.

Watershed Surveys

The cooperating agencies on the Youghiogheny River, Pa., detailed survey are entering the final stages of their considerations in this watershed. At a meeting of the Field Coordinating Committee, September 30, 1939, was set as its completion date.

Appalachian

Preliminary Examinations.

The Preliminary Examination report covering the New River drainage, above the proposed Bluestone Flood Control Reservoir, has been given final review by the Field Committee. The Preliminary Examination report on the Big Sandy River in West Virginia, Kentucky, and Virginia and on the Little Kanawha River in West Virginia will be ready for committee review at an early date.

A public hearing by the Agriculture and War Departments was held on the Meherrin River in North Carolina and Virginia on May 23. Testimony received at the hearing indicated that flood problems in this watershed are typical of many Lower Piedmont and Coastal Plain drainages where flooding of extensive bottom lands occur.

Intermountain

Preliminary Examinations

A Preliminary Examination report upon the Virgin River has been forwarded to Washington, that for the Sevier River watershed in Utah is nearing completion, and that for the Weiser River in Idaho has been initiated.

Watershed Surveys

Significant progress has been made on the Boise River watershed survey by the plant-soils relationship, engineering, and economist crews.

The plant-soils group has completed a reconnaissance survey of the foothill and main valley portion of the watershed. Using aerial photographs, data have been obtained on the physical conditions of the area and estimates have been made of the kind and amount of remedial measures which are required for flood control, run-off retardation, and erosion prevention purposes. Crews are now obtaining similar information on the upper and mountainous portion of the watershed. Because aerial photographs are not yet available, this survey is being made on a spot sample basis. Observations are being made on a sufficient number of 100-acre sample spots to obtain 5 percent, 1 percent and 1/2 percent coverage on seriously, moderately, and slightly eroding areas, respectively.

Another crew is obtaining infiltration capacity measurements on three "guinea pig" tributaries using the newly developed North Fork infiltrometer. The watersheds selected for this study are about 4,000 acres in size and are characterized by burned, cut-over,

and virgin ponderosa pine cover conditions, respectively. They are three of the thirteen tributaries on which the U. S. Geological Survey is measuring streamflow and silt load. It is expected that infiltration measurements on the significantly different cover conditions when correlated with differences in stream flow and silt yields, will serve as a basis for estimating the benefits to be derived from proposed watershed improvement measures. Similar relations are being analyzed for range watershed areas on which comparable infiltration data are available from previous studies.

The engineering crews have completed a compilation of structures needed for flood and erosion control purposes on the foothill portion of the watershed and are now gathering similar information on the headwater areas. A determination of flood flow expectancies through analysis of hydrological and meteorological data is nearing completion. The District Engineer of the Corps of Engineers at Boonville, Oregon detailed a hydraulic engineer to the project staff for a period of several weeks to assist in this analysis. The Corps plans to cooperate further assisting in the delineation of flood zones for floods of different stages and frequencies, and in determining the effectiveness of all proposed major engineering structures. A detailed physical survey of the flood plan by the Corps of Engineers is nearing completion.

The economic section has completed a tabulation of recent flood damages and is now conducting surveys to determine the characteristics and value of the various enterprises as a basis for determining the cost-benefit ratios of proposed remedial measures. By request, much of the data on damages and land use values have been made available to the Corps for their report. Provision has been made also for collaborating with the Corps in developing cost-benefit relations.

Lake States

Watershed Surveys

Kickapoo River. As the Kickapoo River survey nears conclusion, it has been decided to study the effect of floods on game and fish. Several meetings were held with the Army and other interested agencies to determine a satisfactory method of damage appraisal.

The study will be made by biologists from the Soil Conservation Service and the Regional Office of the Forest Service, and will attempt to estimate the original game population and the number that can be supported if a land use flood-control program is put into effect.

Northeastern

Watershed Surveys

In connection with snow surveys of this past winter in the Smith River basin and in the Franconia Notch on the headwaters of the Merrimack River, the following effect of various types of vegetation on snow conditions was found:

Snow accumulation under hardwoods was, in general, deeper than under softwoods or in the open.

Snow under hardwoods showed a greater tendency to form ice layers and crusts and appeared in most sections to be more powdery and less granular than snow under softwoods or in the open.

In hardwood stands there was no soil freezing, but under softwoods and in the open in almost all sections the soil froze to considerable depths and a heavy layer of ice formed on the surface of the soil.

There seemed to be very little difference in the times when the snow finally melted away under hardwoods and softwoods in spite of differences in depth and character of the snow as noted above, but in both cases it lasted longer than in the open.

Pacific Northwest

Watershed Surveys

Research. An analysis was made of the meteorological and hydrologic data for stations within the Willamette watershed to determine the relative importance of the various tributaries in contributing to floods and flood damage. The tributaries can logically be classified into three groups; those rising in the Cascade Range, those rising in the Coast Range, and the valley streams. It was found that the Cascade tributaries have a higher mean discharge per square mile than the Coast Range or valley streams. Data also indicated that the bulk of the run-off causing winter floods originates on the central and lower slopes. The five most important tributaries are believed to be the Coast Fork, Long Tom, Middle Fork, McKenzie, and Santiam, in the order named.

Southern

Preliminary Examinations

A preliminary examination has recently been completed for the Pascagoula River basin (Mississippi and Alabama), and reports are essentially completed for the Ouachita (Arkansas) and the Homochitto (Mississippi) Rivers. Interesting problems in report preparation were encountered in all three basins. The Pascagoula report was a rush job, completed in about two weeks, which included three days in the field. In the instance of the Ouachita, some flood-damage data are available but they were inadequate for the area with which the Department of Agriculture is mostly concerned. No damage data were available for the Homochitto River basin. In both instances, reconnaissance field work was carried on by representatives of the co-operating bureaus, mostly for the purpose of securing flood-damage data. Aerial photos, mostly in county farm agents' offices, proved to be valuable in the determination of the location and amount of developed flood-plain land. A damage questionnaire was used in the Homochitto basin which was carefully designed to secure a maximum of essential data and still be concise and workable. It was used in the field with relatively small groups of farmers and residents, with ample supervision by the three bureau representatives and county agents. County agents also gave excellent service in publicizing these informal "hearings." Only one week's time was spent in the field and 40 percent coverage was secured. This method of getting flood-damage information first-hand is considered the most successful yet used by this committee. The Southern Station is cooperating with the Soil Conservation Service and Bureau of Agricultural Economics on the preparation of reports for the Upper and Lower Red River and for the Savannah and Apalachicola Rivers.

Watershed Surveys

Field work on the Little Tallahatchie River (Mississippi) survey is progressing rapidly. Delineation and planimetering of 20-odd categories of land use and condition, each requiring specific corrective measures, have been completed for several weeks. This has included practically complete coverage for the basin through the use of aerial photos and supplementary field examinations.

Field work on the Trinity Survey (Texas) is nearing completion. The survey method of the Concho Survey (Texas) has recently been revised by the field working committee. The nucleus of the adopted method is delineation and planimetering of land-use condition categories on aerial photographs similar

to the method used in the Little Tallahatchie Survey, but on a randomized 20 percent sample. Homogeneity of topography, land use and condition, associated with high visibility, have permitted rapid progress in this phase of the study. The various land categories are observed in the field and direct delineation is made on aerial photos.

Olsen, Senior Forest Service representative on the Trinity Survey, and Cortright of the Tallahatchie staff attended the recent short course on the use of the North Fork infiltration apparatus at Chickasha, Oklahoma. It is doubtful, however, if apparatus will be available in time to permit infiltration studies being made on the Trinity Survey. Personnel from this Station will have an opportunity to see five or six infiltration-study methods in use on the South Concho Survey. This survey is being used as a "guinea pig" to compare various types of apparatus.

INFLUENCE OF NATURAL VEGETATION ON STREAMFLOW

California

Chaparral

San Dimas Experimental Forest. In cooperation with the staff of the Angeles National Forest and at their request, a short course in Watershed Management was given at the annual Forest Fire Guard Training Camp May 22-24. The subject was presented in four periods of two hours each by H. C. Storey and E. L. Hamilton of the San Dimas staff. Each period was divided into lecture, discussion and presentation of illustrative data. The course stressed the fact that fire protection is carried on not as an end in itself but as an integral part of the management of mountain watersheds. The attendance, originally scheduled for 25 men, totalled over 40.

Research Results. Preliminary study of quantity of ground water flow and storm flow for one watershed of the San Dimas Forest has developed some interesting relationships. Fern Intermediate Watershed during the season 1936-37 received an average of 46.31 inches of precipitation, of which a large portion was in the form of snow. The total streamflow amounted to 11 percent of the precipitation. Of the total streamflow 70 percent was ground water flow. Separating the ground water flow from the total stream flow, it was found that only 3 percent of the rainfall ran off as storm flow. This type of analysis is being continued so that eventually these various quantities can be compared for different watersheds.

A record of spring flow has been started by installation of a recorder at a spring in Fern Canyon. This will yield figures upon the rate of depletion as well as relationship between supply and use. It is planned to study all our developed springs and prepare depletion curves for comparison with ground water depletion curves developed from hydrograph analyses.

The run off and erosion data from the Tanbark and Fern Plots have been summarized for the period 1933-1939 in the accompanying table. The results from the nine plots comprising each series have been combined so that they are treated as one unit. The results for the four seasons with uniform and untouched vegetative cover are quite similar for both groups of plots, but since the Fern Plots were swept by a forest fire last November the picture has changed considerably. The rainfall for the 1938-39 season was subnormal and 50 percent of it fell in one storm which was characterized by quite moderate intensities. At least 30 percent of the precipitation on the Fern Plots was in the form of snow which melted slowly and produced very little run off. It is of interest to note that the total erosion from the Fern Plots was of two types: 26.5 cubic feet per acre slid off the slopes in the form of dry creep before any rain occurred, and 218.5 cubic feet was due to rain action.

Five-Year comparative record

Tanbark and Fern runoff and erosion plots

1933 - 1939

| Rain season | Inches depth | | Runoff | | Runoff percent | | Erosion per acre | |
|-------------|--------------------|-----------------------|--------|-------------------|----------------|---------|------------------|-------------------|
| | Precipitation | | | | | | cu. ft. dry | |
| | Fern ^{1/} | Tanbark ^{2/} | Fern | Tanbark | Fern | Tanbark | Fern | Tanbark |
| 1933-1934 | 40.0 | 24.62 | | Record incomplete | | | 2.0 | 2.0 |
| 1935-1936 | 25.05 | 22.04 | 0.24 | 0.07 | 0.96 | 0.39 | 1.0 | 3.0 |
| 1936-1937 | 44.13 | 41.02 | 0.28 | 0.05 | 0.63 | 0.12 | 1.0 | 4.0 |
| 1937-1938 | 52.42 | 45.06 | 0.22 | 0.32 | 0.42 | 0.71 | 2.0 | 3.0 |
| 1938-1939 | 22.00 | 20.21 | 1.16 | 0.01 | 5.26 | 0.05 | 245.0 | 1.0 ^{3/} |

Fern plots burned over November 1938 by San Antonio fire

^{1/} Elevation 4900 feet, unburned since before 1888. Total area 0.225 acres.

^{2/} Elevation 2750 feet, unburned since 1919. Total area 0.225 acres.

^{3/} This figure is approximate.

The San Dimas' large lysimeters, still in their settling period and without vegetation, have passed through their second rain season. The following table presents the average performance of 25 lysimeters for the rain season 1938-1939, to and including May 27, 1939:

| | Precipitation | Runoff | Seepage | Total water yield | Retention and evaporation |
|--|---------------|--------|---------|-------------------|---------------------------|
| Seasonal total to 5-27-39 incl. inches depth | 20.13 | 7.88 | 3.21 | 11.09 | 9.04 |
| Percentage of total precipitation | | 39 | 16 | 55 | 45 |

There was a slight acceleration in the daily seepage rate during the month of April. There was a definite break in the rate about May 1 and it has decreased somewhat during the month. The variation in seepage rates between different tanks is indicated as follows:

| | Daily seepage rate in inches of rain | | |
|---------------|--------------------------------------|-------------|--------------|
| Lysimeter No. | 11 (Minimum) | 6 (Average) | 19 (Maximum) |
| April | .024 | .025 | .043 |
| May | .017 | .019 | .025 |

Woodland Cover

Big Creek Watersheds. The 1938-1939 precipitation season continued subnormal through April and May, during which time less than one inch of rain was received. This brought the total for the season to 16.8 inches, or approximately 50 percent of the 1936-1937 seasonal precipitation of 33.5 inches (tentatively considered as the normal for this region), and 41 percent of the 1937-1938 season of 41.5 inches.

Throughout the season, precipitation occurred in 24 very moderate storms. The maximum storm produced 1.9 inches on March 10 and 11. Runoff has been correspondingly low, and preliminary study indicates that the total water production from the area will be less than 5 percent of the seasonal precipitation as contrasted with about 20 percent for the 1936-1937 season, and 30 percent for the 1937-1938 season.

Teakettle Creek Watersheds. The April forecast by the State Division of Water Resources, based on snow surveys of the Kings River area, indicates that a spring runoff of only 45 percent of normal may be expected. Rapid melt of this subnormal snow pack has continued during April and May and will contribute to an expected serious water shortage for summer irrigation in the San Joaquin Valley. This is supported by general observations and snow measurements conducted on the Teakettle Creek watersheds which are summarized in the following tables:

Table 1. General observation of snow conditions, Teakettle Creek Watersheds, April-May, 1939.

| Percent of ground snow covered | | | | | | | Temperatures °F | | | Precipitation (water equiv.) |
|--------------------------------|------|----|------|----|------|----|-----------------|---------|---------|---------------------------------|
| Elev: Exposure | 7000 | | 7500 | | 7670 | | Period | Maximum | Minimum | |
| Date | N | S | N | S | N | S | | | | <u>Inches</u> |
| 4/18 | 70 | 15 | | | | | 3/31-4/17 | 65 | 20 | 3.38 |
| 4/25 | 30 | 5 | 75 | 20 | 85 | 47 | 4/17-4/25 | 68 | 29 | 0.14 |
| 5/4 | 15 | 1 | | | | | 4/25-5/4 | 66 | 32 | None |
| 5/15 | 1 | 0 | | | | | 5/4-5/15 | 68 | 31 | None |

Table 2.- Key snow course measurements, Teakettle Creek Watersheds,
April-May, 1939

| Date | Elevation | Average snow | | Density |
|------|-----------|--------------|-------------------|----------------|
| | | Depth | Water Content | |
| | | | <u>Inches</u> | <u>Percent</u> |
| 4/18 | 6700 | 12.7 | 6.7 | 53 |
| 4/25 | 6700 | 4.3 | 2.1 | 49 |
| | 7670 | 28.1 | 13.3 | 47 |
| 5/4 | 6700 | | No snow on course | |

Model Studies of the San Dimas Type Flume. Check runs of clear water studies of the San Dimas type flume, being carried on at the Hydraulic Laboratory of the University of California, are nearing completion. These runs have been concerned with checking original results obtained with the half-scale model, using various floor slopes and friction conditions. The check runs have verified the original experiments within a range of 2 to 3 percent.

Intermountain

Grassland

Snow melting and spring runoff characteristics which have been observed during the last four years in the high Wasatch Mountains of Utah are not in complete harmony with popular accepted beliefs concerning these phenomena. The following statements which may be considered approximations based on observations principally, but to limited extent on Watershed A and B findings, apply particularly to soils, temperatures, and plant cover as they occur on the Ephraim Canyon watershed and vicinity of the Manti Forest.

1. As long as temperatures (inside instrument shelter) do not exceed 48° C, the rate of snow melting does not exceed the infiltration capacity of the soil and no overland flow (surface runoff) of water is visible.

2. When temperatures exceed 48° C, the melting rate exceeds infiltration capacity of the soil mantle where partly or completely denuded of vegetative cover but not on soil well covered with grasses and shrubs.

3. On well vegetated soil there is practically no evidence of overland flow from melted snow water, whereas on denuded areas overland flow during short periods of high temperature has been sufficient to erode gullies which provide channels that greatly facilitate flood runoff during summer rainstorms.

4. Flow of Ephraim Creek increased from less than 10 to 100 c.f.s. without evidence of appreciable overland flow of water. Source of water for this increased flow was (a) snow melting directly into stream channels and gully systems, and (b) seepage (bank yield) at gullies and stream channels principally from the supersaturated soil mantle.

5. Major soil erosion during spring runoff results during short periods of overland flow, whereas erosion is only slight where increased flow is derived from seepage or bank yield.

These observations support the hypothesis that a large percentage of increased stream flow, commonly called spring runoff, is not overland flow (surface runoff), but seepage flow from the supersaturated watershed soil mantle into which most of the melted snow water penetrates as melting occurs.

Plans are under way to study spring runoff characteristics more fully by supplementing measurements at Watersheds A and B with measurements of Ephraim Creek and runoff from snowbank areas on denuded and plant-covered soils.

Rocky Mountain

Forest

Snow storage study. Snow surveys on twenty five-acre cutting plots at the Fraser Experimental Forest were carried through this year, as in 1938, by weekly measurements at 500 stations. At the beginning of the melting season--about April 1--over seven inches less snow was in storage this year than last. This difference in stored snow represented almost an inch less water. Melting this spring proceeded at a rate very similar to that of last year, but was consistently a week ahead. The last snow left the plots by the final week of May, while June 1 marked its disappearance in 1938.

Southern

Forest

Irons Fork Experimental Forest. A major storm occurred at Irons Fork on April 15 and 17, approximately 6 inches of rain falling in 32 hours. This storm produced the largest discharges observed to date at the stream-gaging stations on Hoover and Nesbitt Creeks. Discharge-rating work has been carried on by Collet at four controls during recent months, but the April storm furnished the first opportunity to gage flow of the streams at peak stages. Collet and assistants were on the ground during the entire storm and obtained velocity readings at or near the crest for each of these stations. Compilation and analysis of the discharge data is now under way and discharge-stage curves are being prepared. Three instruments, namely, the Price current meter, the Bentzel velocity tube, and the San Dimas jump stick, were used to obtain velocities. Velocities up to 7 feet per second were measured while the more turbulent flows were in progress. Considerable movement of sizeable boulders along the beds of the streams took place during the heaviest flows. A special calibration beam, recently developed by Collet, was used in the rating discharge. This is a simple calibrated wooden beam provided with a moveable clamp for holding the velocity instrument. The beam is placed across the channel control section and by setting the velocity instrument at the desired depth, very accurate depth-velocity measurements can be taken in rapid succession. There is special need for such a device when gaging the flow of small, flashy streams, since appreciable changes in stage may occur in a matter of minutes.

Observations were continued on the performance of the 13 small water-storage dams constructed in Rock Creek. These dams are earth or rock fill with earth aprons and provided with a center core wall or diaphragm of tightly compacted clay or of logs. The dams were put in as preliminary trials to determine whether feasible to construct low-head storage dams in steeply pitched channels and to determine through observations whether these dams provide appreciable storage for stormflow. The present dams are not provided with outlets other than lateral spillways and dependence is placed on natural seepage or evaporation to empty them. During the winter months a few of the reservoirs have remained dry most of the time, filling to capacity during storms and emptying within a few days. The majority of the structures have tended to seal up through siltation induced by construction activities, and consequently remain full of water most of the time. At small additional cost, small outlet pipes can doubtless be installed in dams of this type, thereby converting them into retarding works rather than storage dams and greatly

increasing their effectiveness for the storage of flood discharge. Observations made in connection with the construction of the Rock Creek dams indicate that earthen structures are more cheaply constructed and more water-tight than those of earth and rock material. Shale soils were found to provide the best construction material. It proved feasible to maintain close moisture-content control of earth materials going into the dams, and it was found advisable to discontinue construction when moisture content of the soil dropped below 15 percent oven-dry weight. Timber diaphragms were used in core-wall construction with good success. Wide, shallow spillways were found to be better than the narrow type. Some overtopping of dams occurred due to too-small spillway design during the heavier rains. The design and protection of spillway outlets obviously need additional study.

During the recent 6-inch storm observations were made on the performance of recently installed diversion-spreader works. These devices are designed to divert storm runoff from the channels of steep-gradient mountain streams, and carry it along the contour to points sufficiently above the water table where it can be turned back into the soil or rock mantle by means of spreading works. Eight diversion-spreader systems have been constructed to date in Rock Creek, these being of several types. Some of the diversion-spreaders are provided with low masonry baffles to divert water from the channel, while in others stormflow is merely diverted through a side outlet. Various devices are used to spread the water after it has been diverted. In some cases the diverted water is spread through a series of pits or rectangular trenches one emptying into the other, while in other instances the water is merely turned into rock talus or spread in broad, shallow flows over the natural ground surface. The present trial structures are designed to divert up to about 20 second-feet of stormflow. During the April storm one of the structures diverted all of the runoff from the 6-inch rain, emptied it into a series of trenches from the lowermost one of which there was no outflow, and in short performed perfectly in disposing of all the storm discharge from the watershed area above. There was no indication that the water thus turned back into ground-water storage escaped back into the stream channel farther downstream. The other diversion-spreader structures performed with varying degrees of success but in some, considerable amounts of the diverted stormflow quickly reached the stream channels lower down via the surface route or as subsurface flow. This was particularly noticeable in the case of water diverted into talus areas. The use of diversion-spreader systems on upper mountain slopes such as these appears to be somewhat of an innovation in upstream engineering, and much experimental work remains to be done before feasibility of such methods can be established. The present trials have already indicated that a major need in the construction and effective use of these works is for practical methods of ascertaining the structure and composition of the underlying soil

and rock material, since these will largely determine whether diverted runoff can be safely stored and whether the method accomplishes any considerable retardation in delivery of this material to streams.

An informal study was started in April to observe some of the effects of forest cutting practices on surface runoff, erosion, and litter decomposition. This is in the nature of a short-term empirical study, but affords considerable promise of providing some excellent leads to future watershed studies in the Ouachita Mountain region. The study is being made in connection with a timber-sale operation on the Jones Creek watershed located within the Experimental Forest. An extensive inventory of forest litter on this area was made prior to logging operations, after which the various units of the Jones Creek watershed were logged according to cutting and slash-disposal practices prescribed by the Station. These watersheds range in area from 35 to 56 acres. Two of the units were given a light Forest Service selective cut, in which approximately 40 percent of the merchantable volume was removed, with the slash being lopped and scattered according to standard Forest Service practice. Two units received a similar cut but on these areas the slash was left intact. On two units, all of the merchantable stand was removed and slash was not disposed of, while on the remaining unit, also clear-cut, the slash was lopped and scattered. After logging, two installations, consisting of a sheet-metal settling tank, a 90-degree V-notch weir and water-level recorder, were installed to measure the surface runoff and erosion from a section of logging road and from a skidway. Several additional installations of this type are to be put in later. Some small surface runoff plots will also be put in on the logged-over areas to compare the overland-flow contributions from land on which the ground cover has been altered in varying degrees. As soon as the logging operations are completed, a survey will be made to determine the location and extent of areas affected by skidding operations. Additional litter inventories will be made periodically. Since the Ouachita National Forest desires information on tree reproduction obtained on land logged in various ways, the Management Division plans to put in some study plots on the Jones Creek area.

STABILIZATION OF SOILS

Appalachian

Roads

Road Banks. Comparisons of the results of the different types of mulching in creating natural seeding areas on roadbanks are now available. Under the light weed mulches, cut and applied during September and October, a considerable number of perennial and biennial species became established during the fall months and survived the winter successfully. Annual species appeared in the spring as soon as the banks were sufficiently warm. Best results have been obtained where light mulches of rich weed growth have been applied to fertile slopes, where vegetation establishment appears to be assured without further treatment. Although the fewest seedlings have appeared after one year under heavy woods litter mulches packed on sterile slopes, this method seems to have merit in improving the banks for future plant growth. Where slopes of 3 - 1 or more are encountered, it now appears to be more practical to haul weed and straw material a considerable distance than to hold hardwood leaf litter on very steep banks. On lower slopes where it is not so difficult to hold the leaf litter in place, it appears feasible to use the local woods litter.

At Coweeta extensive experiments in fertilizing and seeding under different types of mulches have just been completed. Although it is too early to report the results of these experiments, it is believed that very favorable returns can be obtained for relatively small outlays of grass seed and fertilizer.

Chemical Stabilization of Roads. A study has just been completed by Minckler on various phases of chemical road stabilization with CaCl_2 and NaCl . Although the study was not as intensive as originally planned, because of delay in treating the road, several important conclusions have been reached:

1. As much as $1/4$ pounds of calcium chloride per square yard may be leached from treated roads during the first five inches of rainfall. The amount lost in this way varies greatly from place to place on the road.

2. Tests with potted plants indicated that road runoff is not injurious to vegetation. The highest concentration of culvert water obtained was about 0.52 percent. It has been found elsewhere that a 6.2 percent solution of CaCl_2 was not injurious to grass plots. So far the treatment apparently has been effective in eliminating dust.

3. There was a maximum increase in solute concentration of 8 parts per million in a stream adjacent to the treated road. The natural fluctuation of the stream however, was over twice this amount, the difference being significant. CaCl_2 and NaCl are not poisonous in themselves but depend upon high concentration for injurious effects to fish or fish food. For this reason, it is unlikely that they will have any damaging effect upon the stream fauna. Opinions of fish specialists have been sought in this regard.

Southern

Roads

Holly Springs roadbank-stabilization studies. Working plans have been drawn up to govern the establishment of 20 additional roadbank plots comprising about 3,600 linear feet of roadbank with an average height of 6 feet. Establishment of these plots, together with subsequent observations, will probably bring to near-completion the roadbank studies that have been under way on the Holly Springs National Forest during the past 3 years. These concluding trials are devoted to additional tests of seed mixtures, mechanical covers and mulches, sodding methods, and ways and means of decreasing the amount of topsoil necessary to establish a successful plant cover, the use of topsoil being the principal item of cost in most of the highly successful treatments developed to date. The present spring work schedule calls for drawing up recommendations and furnishing technical guidance to the Administrative branch to govern the application of recommended treatments on road projects on the Holly Springs National Forest. However, an unusually severe fire season has prevented any extensive work on going road projects, and large-scale erosion-control treatments may have to be deferred until the next growing season, since previous trials have demonstrated that erosion-control measures cannot be most effectively applied to roadbanks during the fall or winter seasons. Application of the results from the Holly Springs roadbank studies will doubtless find considerable application outside the Service. These studies were recently inspected by the Director of the Mississippi Experiment Station, who has offered at some future date to call a conference of all agencies concerned with road-building in the State of Mississippi, in order that the methods developed at Holly Springs can be made available and put into practice.

RANGE RESEARCH

ARTIFICIAL REVEGETATION

California

Promising legumes for revegetation on foothill ranges. Among the many annuals tested for survival at the San Joaquin Experimental Range during the past four years, two groups are of especial interest - subterranean clovers and bur-clovers.

For the first two years subterranean clover gave only mediocre results. In comparison, it did exceptionally well in the forage nursery during the 1937-38 season, producing a vigorous growth of forage and an abundant seed crop. Nearly three quarts of seed pods were harvested from each of the rod-long rows, and enough seed remained on the ground to produce a heavy mat of new growth the following fall. Growth at the Range was best where the seed had been inoculated. Also, results were much superior on sandy-lean soil than on heavy adobe soil, an indication in accordance with reported behavior of subterranean clover in Australia, where the plant is rated as good forage.

Of particular interest in the fair showing of the plant during the season just ended, 1938-39, one of very light precipitation - approximately 12 inches in comparison with about 32 inches in the 1937-38 season. Many of the runners have attained a length of 1 foot, and a moderately heavy crop of burs has been produced.

The testing of several new strains of subterranean clover was begun during the past season. Of these, the one that showed most promise was the Wallendbean strain, a later strain than the ordinary one previously tested. In spite of this, however, it has produced an equal or greater amount of forage and a fairly good crop of burs. The strain known as Certified Termanian placed second but did not yield as much top growth or as large a crop of burs as either the ordinary strain or the Wallendbean strain. Three of the strains tested last year, a Mt. Baker strain, Tallarook strain, and Earlistrain, showed practically no promise.

Since new strains of subterranean clover adapted to a wide range of climatic and soil conditions are being developed steadily by plant breeders, encouragement is offered for further testing of this group in California, where growth factors even in the foothills vary so widely.

We are watching with considerable interest several new bur-clovers, 20 species of which have been tested during the past two years. Most of these have larger burs than the common and widespread

California bur-clover, and from this standpoint would appear to be superior. Tested alongside California bur-clover, most of the new species have matured later although several have yielded more forage and equally large crops of burs. For these and other reasons, the bur-clovers warrant further testing, especially in areas where the California bur-clover thrives.

Purple and hairy vetch were tested on the Experimental Range for the first time last year. In the nursery, purple vetch attained a height of 3 feet, and produced many flowers and a moderate seed crop. Owing to the lack of rain late in the season, some seed pods failed to mature. Hairy vetch grew only about half as high as purple vetch but made considerable winter growth, and is rated of about equal promise for further testing.

GRAZING MANAGEMENT

Intermountain

Summer Ranges

Quadrat Studies of Individual Plants. During the last winter an ecological analysis was made of the data from five meter-square quadrats, charted for 13 consecutive years. The quadrats, two fully protected, two grazed season long, and one seasonally grazed, were charted from 1926 to 1938, at the upper limit of the oakbrush zone near the Greck Basin Branch Station. The intensity of grazing, by cattle, sheep, and wildlife, has varied from year to year, but in general seems to have been rather moderate. Although the analysis with emphasis on individual plant history is not entirely finished some of the more apparent results are presented.

In general grasses increased in area from 1926 to 1931, and then between 1931 and 1938 they decreased in area and the larger tufts tended to break up. Shrubs increased in number and area, especially between 1931 and 1938, when in suggestive contrast to the decline of grasses, they made a rapid increase.

Longevity -- In table 1 are shown two kinds of life spans: (1) the average duration of all plants is given; (2) the average duration of those plants that presumably become "established"; i.e., living two years or more.

Table 1. - Life span in years according to species of all plants and of those that became established.

| Species | All (Years) | Established (Years) |
|---------------------------|----------------|------------------------|
| Agropyron pauciflorum | 1.7 | 4.6 |
| Agropyron spicatum | 2.5 | 6.5 |
| Bromus anomalus | 2.0 | 3.9 |
| Stipa columbiana | 1.9 | --- |
| Stipa lettermanni | 2.7 | 4.8 |
| Artemisia tridentata | 1.3 | 3.6 |
| Symphoricarpos oreophilus | 3.2 | 5.0 |

For the more prominent species, the usual life span for established grasses on these plots seems to be 3-6 years. The table indicates that the same is true for shrubs, but inasmuch as these shrubs have been invading since the time of establishment of the quadrats, the span of 3-6 years is probably incomplete. For most herbs longevity is somewhat less than for grasses. The maximum life span of established plants of all these species, excepting Stipa columbiana for which the fewest data are available, is known to be 13 years or longer.

Germination -- The number of grass seedlings was generally greater on protected than on grazed quadrats, probably reflecting the presence of a more abundant seed supply. A close relationship seems to exist between the production of seedlings and high June or summer rainfall. That the correlation is not very consistent indicates that other factors are of considerable importance. For example, although June and total summer rainfall were approximately as favorable in 1930 as in 1936, Stipa lettermanni produced twelve times as many seedlings in 1936 as in 1930.

Survival -- For grasses and sagebrush the years with the highest seedling crops had the highest survival in terms of total numbers, but the percentage survival was often higher in the years when fewer seedlings were produced. In the example mentioned above, although many more established plants of Stipa lettermanni resulted from the 1936 seedling crop, the proportion of survival was twice as high in 1930. Survival of Stipa lettermanni and Symphoricarpos was greater on protected than on grazed quadrats. Survival of Artemisia showed little response to treatment. Gross survival percentages are as follows: Symphoricarpos 47 percent, Stipa lettermanni 45 percent, Bromus 37 percent, Artemisia 18 percent, and Agropyron pauciflorum 12 percent.

Effects of shading -- All the principal species observed seemed to germinate as readily in the shade of bushes as in the open. Species which apparently have no difficulty in becoming established in the shade are Bromus, Stipa lettermanii, and Chrysothamnus lanccolatus, the last named ordinarily considered a light-loving species. Artemisia and Agropyron pauciflorum seem to have difficulty in becoming established in the shade, and Symphoricarpos especially in the shade of Artemisia or Chrysothamnus. Agropyron spicatum tufts were among the most conspicuous in breaking up as the shade of sagebrush increased.

Effects of rodents -- Although grasses and Symphoricarpos germinated more or less readily on rodent-disturbed areas they did not become established and survive there as well as on undisturbed soil. Artemisia and Chrysothamnus seemed to become established readily on rodent-disturbed soil, as is further shown by the marked invasion of these species during the past few years, in which rodent workings seem to have been most extensive. The sudden disappearance of colonies of Archillex lanulosa upon advent of rodent workings gives rise to the assumption that these disappearances (and perhaps the similar reactions of Vicia americana and Alsine jamesiana) are the result of rodents utilizing the underground parts for food.

The above results are suggestive to plant response but need to be amplified by further study of the same species on other quadrats. It is desired especially to arrive at some method by which competition may be detected with certainty and accurately measured. The Great Basin quadrat records, although imperfect in many ways, contain data collected over a fairly long period of time, and therefore, present an unusual opportunity to secure facts on the life history of range plants.

Utilization Standards

Problems in Measuring Range Forage Utilization for Grasses. Volume-height tables were prepared for 23 species common to summer range types in the vicinity of the Great Basin Branch Station and preliminary tests of these tables were made at the close of the 1938 grazing season. Determination from such tables of utilization for the broadleaved herbs was reported earlier. This report considers some of the difficulties encountered in making accurate utilization estimates, and some of the inadequacies of volume-height tables for determining the utilization of grasses.

The application of volume-height tables to field use is based primarily on two premises: (1) That the data in the table are representative of the species under field conditions, and (2) that various height classes of grazed species can be grouped

to obtain an average height for that species on the plot or area as a whole. If, in preparing the table, a sufficiently large sample of a given species is drawn at random from ungrazed but not especially protected plants, the first premise should be met. Difficulties encountered in the second premise, however, are not so easily overcome. The unequal distribution of plants of various sizes, and the fact that the different sized plants are not grazed equally at random makes it difficult to obtain an average height from a grazed plot which can be expected to agree with the sample which was artificially sectioned in building up the table. Table 1 gives the percentage volume by inch sections for 66 slender wheatgrass plants, which show a nearly normal distribution, by 4-inch height classes from 9 to 40 inches. Similar volume-height relationships were found for other species.

In preliminary tests it was found that volume-height tables for bunchgrasses were rather reliable when the herbage is closely utilized, that is, 85 percent or more, as was the case on many areas. When 85 percent use has been attained for such species as mountain brome and slender wheatgrass, the plants have been grazed to an average stubble height of about 2 inches with only an occasional flower stalk left. In such instances volume-height tables are unnecessary to determine that excessive overgrazing has resulted. However, when slender wheatgrass and mountain brome plants are grazed to about 70 percent, in which case some 10 to 15 percent of the flower stalks are left and stubble height varies from ground level to ungrazed tufts, then the average height to which the stubble is grazed is difficult to determine and volume-height tables are correspondingly unreliable.

Under actual range use there is a tendency for the smaller plants to be more closely grazed than the larger ones, owing apparently to the fact that a cow, and for small plants even a sheep, can crop the entire plant in a single bite. New growth from these plants is fresh and tender and is taken more readily at successive grazings than is the more mature and tougher leaves and flower stalks from the larger plants. In grazing larger tufts, especially in late season, stock, particularly sheep, tend to trim around the edges and take the basal leaves rather than to graze the plant down to a readily distinguishable level. Grazing in this fashion can remove a considerable amount of the herbage without being easily recognized and accordingly not given full consideration in making average height determinations. Similarly, in actual range use a portion of the plant is often closely cropped, and the remainder left ungrazed. To graze one-half of a plant, say 20 inches in height, to ground level and to top evenly the remaining flower stalks at 15 inches would result in over 53 percent utilization instead of about 35 percent as shown for plants in the 17- to 20-inch height class when grazed to an average stubble height of 7½ inches. The values based on all plants would show about 45 percent use for this height.

Effects of shading -- All the principal species observed seemed to germinate as readily in the shade of bushes as in the open. Species which apparently have no difficulty in becoming established in the shade are Bromus, Stipa lettermanni, and Chrysothamnus lanccolatus, the last named ordinarily considered a light-loving species. Artemisia and Agropyron pauciflorum seem to have difficulty in becoming established in the shade, and Symphoricarpos especially in the shade of Artemisia or Chrysothamnus. Agropyron spicatum tufts were among the most conspicuous in breaking up as the shade of sagebrush increased.

Effects of rodents -- Although grasses and Symphoricarpos germinated more or less readily on rodent-disturbed areas they did not become established and survive there as well as on undisturbed soil. Artemisia and Chrysothamnus seemed to become established readily on rodent-disturbed soil, as is further shown by the marked invasion of these species during the past few years, in which rodent workings seem to have been most extensive. The sudden disappearance of colonies of Archillea lanulosa upon advent of rodent workings gives rise to the assumption that these disappearances (and perhaps the similar reactions of Vicia amor-icana and Alsine jamesiana) are the result of rodents utilizing the underground parts for food.

The above results are suggestive to plant response but need to be amplified by further study of the same species on other quadrats. It is desired especially to arrive at some method by which competition may be detected with certainty and accurately measured. The Great Basin quadrat records, although imperfect in many ways, contain data collected over a fairly long period of time, and therefore, present an unusual opportunity to secure facts on the life history of range plants.

Utilization Standards

Problems in Measuring Range Forage Utilization for Grasses. Volume-height tables were prepared for 23 species common to summer range types in the vicinity of the Great Basin Branch Station and preliminary tests of these tables were made at the close of the 1938 grazing season. Determination from such tables of utilization for the broadleaved herbs was reported earlier. This report considers some of the difficulties encountered in making accurate utilization estimates, and some of the inadequacies of volume-height tables for determining the utilization of grasses.

The application of volume-height tables to field use is based primarily on two premises: (1) That the data in the table are representative of the species under field conditions, and (2) that various height classes of grazed species can be grouped

to obtain an average height for that species on the plot or area as a whole. If, in preparing the table, a sufficiently large sample of a given species is drawn at random from ungrazed but not especially protected plants, the first premise should be met. Difficulties encountered in the second premise, however, are not so easily overcome. The unequal distribution of plants of various sizes, and the fact that the different sized plants are not grazed equally at random makes it difficult to obtain an average height from a grazed plot which can be expected to agree with the sample which was artificially sectioned in building up the table. Table 1 gives the percentage volume by inch sections for 66 slender wheatgrass plants, which show a nearly normal distribution, by 4-inch height classes from 9 to 40 inches. Similar volume-height relationships were found for other species.

In preliminary tests it was found that volume-height tables for bunchgrasses were rather reliable when the herbage is closely utilized, that is, 85 percent or more, as was the case on many areas. When 85 percent use has been attained for such species as mountain brome and slender wheatgrass, the plants have been grazed to an average stubble height of about 2 inches with only an occasional flower stalk left. In such instances volume-height tables are unnecessary to determine that excessive overgrazing has resulted. However, when slender wheatgrass and mountain brome plants are grazed to about 70 percent, in which case some 10 to 15 percent of the flower stalks are left and stubble height varies from ground level to ungrazed tufts, then the average height to which the stubble is grazed is difficult to determine and volume-height tables are correspondingly unreliable.

Under actual range use there is a tendency for the smaller plants to be more closely grazed than the larger ones, owing apparently to the fact that a cow, and for small plants even a sheep, can crop the entire plant in a single bite. New growth from these plants is fresh and tender and is taken more readily at successive grazings than is the more mature and tougher leaves and flower stalks from the larger plants. In grazing larger tufts, especially in late season, stock, particularly sheep, tend to trim around the edges and take the basal leaves rather than to graze the plant down to a readily distinguishable level. Grazing in this fashion can remove a considerable amount of the herbage without being easily recognized and accordingly not given full consideration in making average height determinations. Similarly, in actual range use a portion of the plant is often closely cropped, and the remainder left ungrazed. To graze one-half of a plant, say 20 inches in height, to ground level and to top evenly the remaining flower stalks at 15 inches would result in over 53 percent utilization instead of about 35 percent as shown for plants in the 17- to 20-inch height class when grazed to an average stubble height of $7\frac{1}{2}$ inches. The values based on all plants would show about 45 percent use for this height.

Volume-height tables have not been tried on sod-producing species and other plants having rather uniform height and distribution of volume. For this type of vegetation such tables may be reliable and very useful in determining forage utilization. These tables, however, are useful in training to estimate utilization by the ocular method. Further, volume-height tables may be very useful in studying variation in species under different site and range conditions and under climatic fluctuations from year to year.

Table 1.- Volume height table for slender wheatgrass showing the volume of the plant removed at different height levels for plants in various height classes.

| Plant taken to: (inches) | Plant Height | | | | | | | | Average |
|--------------------------------|---------------------------|--------|--------|--------|--------|--------|--------|--------|---------|
| | 9-12" | 13-16" | 17-20" | 21-24" | 25-28" | 29-32" | 33-36" | 37-40" | |
| | Percent of Volume Removed | | | | | | | | |
| 40 | | | | | | | | .00 | .00 |
| 39 | | | | | | | | .53 | (|
| 38 | | | | | | | | 1.06 | (.01 |
| 37 | | | | | | | | 1.59 | (|
| 36 | | | | | | | .00 | 2.44 | .02 |
| 35 | | | | | | | .68 | 2.86 | .03 |
| 34 | | | | | | | 1.16 | 3.71 | .04 |
| 33 | | | | | | | 1.78 | 4.45 | .05 |
| 32 | | | | | | .00 | 2.67 | 5.40 | .07 |
| 31 | | | | | | .07 | 4.11 | 6.78 | .11 |
| 30 | | | | | | .14 | 5.75 | 8.05 | .15 |
| 29 | | | | | | .43 | 6.57 | 9.53 | .20 |
| 28 | | | | | .00 | 1.09 | 7.60 | 10.80 | .28 |
| 27 | | | | | .12 | 1.93 | 8.90 | 12.81 | .44 |
| 26 | | | | | .43 | 3.32 | 10.33 | 14.29 | .73 |
| 25 | | | | | .99 | 4.78 | 11.97 | 15.67 | 1.13 |
| 24 | | | | .00 | 1.87 | 7.19 | 13.40 | 17.36 | 1.74 |
| 23 | | | | .16 | 3.03 | 9.40 | 14.56 | 19.05 | 2.48 |
| 22 | | | | .57 | 4.47 | 12.04 | 16.06 | 21.06 | 3.43 |
| 21 | | | | 1.05 | 6.29 | 14.54 | 17.56 | 22.65 | 4.53 |
| 20 | | | .00 | 1.94 | 8.25 | 17.33 | 19.47 | 24.45 | 5.80 |
| 19 | | | .13 | 3.27 | 10.38 | 20.07 | 21.52 | 26.25 | 7.27 |
| 18 | | | .53 | 4.98 | 12.69 | 22.95 | 23.77 | 28.16 | 8.97 |
| 17 | | | 1.51 | 7.07 | 14.94 | 26.03 | 26.02 | 30.17 | 10.87 |
| 16 | | .00 | 3.34 | 9.46 | 17.28 | 28.67 | 28.48 | 32.82 | 13.02 |
| 15 | | .45 | 6.12 | 11.67 | 19.89 | 31.82 | 30.73 | 35.26 | 15.52 |
| 14 | | 1.37 | 9.24 | 14.39 | 22.64 | 35.04 | 32.98 | 38.23 | 18.29 |
| 13 | | 3.29 | 12.62 | 17.45 | 25.72 | 38.60 | 35.58 | 41.20 | 21.40 |
| 12 | .00 | 5.85 | 16.43 | 20.72 | 28.99 | 42.00 | 39.00 | 44.70 | 24.75 |
| 11 | 1.12 | 8.66 | 20.26 | 24.42 | 32.81 | 45.68 | 42.28 | 48.20 | 28.46 |
| 10 | 2.40 | 12.09 | 24.28 | 28.57 | 37.17 | 49.65 | 45.97 | 51.59 | 32.59 |
| 9 | 4.01 | 15.84 | 28.42 | 33.21 | 41.78 | 53.84 | 49.86 | 55.72 | 36.99 |
| 8 | 8.34 | 20.34 | 33.02 | 38.30 | 47.11 | 58.64 | 54.91 | 59.96 | 42.00 |
| 7 | 14.60 | 25.18 | 38.56 | 44.01 | 52.97 | 63.47 | 59.76 | 64.30 | 47.59 |
| 6 | 24.23 | 31.66 | 44.90 | 50.47 | 58.81 | 68.31 | 63.99 | 68.54 | 53.59 |
| 5 | 35.14 | 39.36 | 52.49 | 57.72 | 65.33 | 73.32 | 68.77 | 73.10 | 60.40 |
| 4 | 47.02 | 48.87 | 61.11 | 65.37 | 71.98 | 79.07 | 75.67 | 77.44 | 67.75* |
| 3 | 60.51 | 60.62 | 70.76 | 74.11 | 79.00 | 84.75 | 81.48 | 82.52 | 75.80 |
| 2 | 74.80 | 72.98 | 80.65 | 82.99 | 85.72 | 89.00 | 87.01 | 89.20 | 83.73 |
| 1 | 87.64 | 87.76 | 90.63 | 91.95 | 92.96 | 94.61 | 93.57 | 94.60 | 92.13 |
| 0 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |

* Approximate P.U. Rating.

Rocky Mountain

Noxious Plant Control

Orange sneezeweed studies. Germination tests conducted during May 1939 with seeds from larvae-infested heads and with seeds from non-infested heads of orange sneezeweed have shown a significant difference in viability of the two kinds. Tests with each kind of seed were run in duplicates of 100 seed each for 25 days. The two tests with non-infested seed germinated 39.0 and 40.0 percent, averaging 39.5 percent; while the infested seed germinated 26.0 and 18.0 percent, averaging 22.0 percent.

It was noted in the field that the larvae ate out the receptacle of the heads before seed maturity and these tests bear out a contention that the viability of the seed would be lowered.

Short Grass Ranges

Forage yield studies on short grass ranges. Analysis of data from sample plots on shortgrass range obtained by estimating density and then determining the clipped weight of both green and air dry forage indicates that a highly significant correlation exists between density and forage weight of individual species. A correlation coefficient of .745 was computed from density-weight data obtained from 16 plots (largely blue grama and buffalo grass) selected to sample a 320 acre pasture. The regression equation resulting from these data was used to compute the weight of forage in an adjoining area on which the weight and density of forage had been obtained by estimating and clipping 22 plots. By means of the regression equation the weight of forage was estimated to be 155.5 grams per 25 square foot plot. The average actual clipped weight from the 22 plots was 161.3 grams or a difference of 5.8 grams (approximately 22 lb. per acre).

On a 320 acre pasture this represents a discrepancy of slightly more than 7000 pounds of forage. It is estimated that the cattle grazing on the Central Plains Experimental Range will require 40 pounds of fresh forage per day to maintain a satisfactory gain in weight and remain in good condition throughout the 7 month grazing season on the experimental range. On this basis, the 7000 pounds of forage represents a discrepancy of approximately 5.8 cow months in the feed estimate for the pasture, or less than one cow unit for the season for the pasture. Since the stocking rate of the pasture is approximately 32 cows per season and since the weights of individual cattle vary as much as 300 pounds it appears that the stocking rate can be computed as closely as the pasture can be actually stocked. These figures are based on usable weight of forage as indicated by existing palatability and proper utilization standards.

The most essential application of these data is that a reasonable number of plots can be estimated, clipped, and the forage weighed in order to establish a regression equation. Numerous plots then may be estimated to obtain replication and adequate sampling of the forage and the weight of forage on the pasture may be computed from this large sample.

Additional study based on large numbers of plots is being made to test carefully the feasibility of this method.

Southwestern

Utilization Standards.

In order to secure additional data for grass volume tables and to study the correlation between percent utilization by weight and percent utilization by volume, 25 tufts of each of 10 principal southwestern range grasses were clipped at 1- and 2-inch height intervals in the 1938 field season. The individual segments were air dried and weighed to determine the vortical distribution of weight for each species. In addition, the volume of the herbage in each clip was determined by liquid displacement.

For the eight species on which tests have been completed, table 1 presents the specific gravity (or ratio of weight to volume) obtained at different height levels and for the entire plant. Table 2 summarizes percent weight taken and the corresponding percent volume taken at various height levels for each species.

Specific gravities of the entire plants were quite uniform, ranging from .92 for hairy grama to 1.12 for bluestem. Within each species there was some variation between different height levels. In three species -- blue, black, and hairy grammas -- specific gravities tended to decrease from the top to the bottom of the plant; just the reverse was true with Arizona fescue where the trend was from higher specific gravities near the base to lower specific gravities near the top. In bluestem, mountain muhly, and black dropseed, specific gravities were high at the top and bottom of the plants and low in the middle; whereas, in curly mesquite, specific gravities were high in the middle and low at the base and top.

If specific gravity were constant throughout the height of a grass, percent weight utilization would be the same as percent volume utilization. Such was found to be substantially true in all eight species because the variations in specific gravity that do occur, as mentioned above, are too small to have any appreciable effect. Table 2 shows the close relationship between percent utilization by weight and by volume. Tests for significance showed no significant difference between the curves of weight utilization against height and volume utilization against height in any of the grasses studied.

Thus for all practical purposes, utilization by weight is the same as utilization by volume.

Table 1. Specific gravities of eight important southwestern range grasses at 10 percent height intervals from top of the plant to ground surface.

| Height interval (percent from top of plant) | Species | | | | | | | |
|--|------------|-------------|-------------|----------------|----------------|----------------|-----------|-----------------|
| | Blue Grama | Black Grama | Hairy Grama | Mountain Muhly | Arizona fescue | Curly Mosquite | Blue-stem | Black Drop-seed |
| 10 | 1.23 | 1.31 | 1.08 | 1.21 | .96 | 1.04 | 1.14 | 1.27 |
| 20 | 1.16 | 1.16 | 1.04 | 1.09 | .96 | 1.08 | 1.12 | 1.14 |
| 30 | 1.09 | 1.05 | 1.01 | 1.03 | .98 | 1.11 | 1.11 | 1.12 |
| 40 | 1.03 | 1.01 | .97 | .99 | .97 | 1.09 | 1.07 | 1.15 |
| 50 | .99 | .98 | .96 | .99 | .96 | 1.07 | 1.03 | 1.11 |
| 60 | .96 | .95 | .94 | .98 | .97 | 1.06 | 1.07 | 1.04 |
| 70 | .96 | .93 | .92 | 1.01 | .97 | 1.04 | 1.10 | 1.04 |
| 80 | .98 | .93 | .91 | 1.03 | 1.02 | 1.02 | 1.10 | 1.11 |
| 90 | .98 | .94 | .91 | 1.04 | 1.03 | 1.00 | 1.17 | 1.13 |
| Entire Plant | .98 | .94 | .92 | 1.01 | .99 | 1.02 | 1.12 | 1.11 |

Table 2. Utilization of eight important southwestern range grasses in terms both weight and volume in relation to height.

| Height taken | | Species | | | | | | | | | | | | | | | |
|--------------|-------------|---------------|---------------|---------------|---------------|---------------|---------------|----------------|---------------|----------------|---------------|----------------|---------------|---------------|---------------|----------------|---------------|
| | | Blue Grama | | Black Grama | | Hairy Grama | | Mountain Muhly | | Arizona Fescue | | Curly Mesquite | | Blue-stom | | Black Dropseed | |
| <u>Pct.</u> | <u>Pct.</u> | Wei-ght taken | Vol-ume taken | Wei-ght taken | Vol-ume taken | Wei-ght taken | Vol-ume taken | Wei-ght taken | Vol-ume taken | Wei-ght taken | Vol-ume taken | Wei-ght taken | Vol-ume taken | Wei-ght taken | Vol-ume taken | Wei-ght taken | Vol-ume taken |
| 10 | 1 | 1 | 1 | 1 | 1- | 1 | 1 | 1 | 1- | 1 | 1 | 1 | 1 | 8 | 6 | 1 | 1 |
| 20 | 3 | 2 | 2 | 1+ | 3 | 3 | 2 | 2 | 1+ | 2 | 2 | 2 | 3 | 17 | 15 | 3 | 3 |
| 30 | 6 | 5 | 3 | 3 | 5 | 5 | 3 | 3 | 3 | 3 | 3 | 2 | 4 | 22 | 22 | 5 | 6 |
| 40 | 10 | 8 | 7 | 6 | 8 | 8 | 5 | 5 | 5 | 4 | 5 | 4 | 6 | 25 | 27 | 8 | 9 |
| 50 | 13 | 11 | 11 | 11 | 12 | 12 | 7 | 7 | 7 | 7 | 8 | 7 | 10 | 29 | 31 | 10 | 11 |
| 60 | 19 | 18 | 18 | 17 | 19 | 19 | 9 | 10 | 10 | 11 | 12 | 12 | 15 | 35 | 37 | 13 | 14 |
| 70 | 26 | 25 | 27 | 27 | 29 | 30 | 14 | 15 | 15 | 20 | 21 | 21 | 24 | 45 | 47 | 16 | 18 |
| 75 | 30 | 29 | 34 | 33 | 36 | 37 | 18 | 19 | 19 | 26 | 28 | 28 | 30 | 52 | 54 | 19 | 20 |
| 80 | 36 | 35 | 42 | 42 | 45 | 46 | 24 | 25 | 25 | 35 | 37 | 38 | 37 | 61 | 62 | 23 | 24 |
| 85 | 43 | 44 | 52 | 53 | 56 | 57 | 33 | 33 | 33 | 45 | 48 | 50 | 46 | 70 | 70 | 29 | 30 |
| 90 | 54 | 57 | 64 | 66 | 70 | 69 | 47 | 46 | 46 | 58 | 62 | 64 | 59 | 80 | 79 | 43 | 40 |
| 95 | 71 | 75 | 79 | 81 | 85 | 83 | 68 | 65 | 65 | 76 | 78 | 80 | 75 | 90 | 89 | 71 | 58 |
| 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |

Noxious plant control

Snakeweed. Studies on the control of snakeweed carried on at the Jornada Experimental Range (see monthly reports of May, June, and December 1938 for further details of snakeweed study) were concerned principally in finding an effective and practical method of killing snakeweed. Accordingly, 200 small test plots (.02 acre) were subjected to various mechanical and chemical treatments at intervals of 3 months starting in the latter part of April 1938. Data were collected in April 1939 from these plots to determine the percentage of kill resulting from the various treatments. The data presented in the accompanying table are based on the percentage kill of mature snake-weed plants. Seedlings were eliminated in the computations since it could not always be determined whether or not they had been subjected to treatment or had germinated and grown subsequently. All plots are in replicate, one set being treated at Middle Station and one at West Station. The soil at both stations is light, sandy, and subject to blowing so that small drifts accumulate about bases of snakeweeds and other plants. The result of this has been that the stem bases of snakeweed are protected and the stems have produced roots or have "layered." Thus the results procured on this soil type should be less effective generally than on more compact clay soils, where the stems are not protected by several inches or more of soil.

The check plots showed little or no change in snakeweed population except in one case where 13 percent of the plants died. Death may have been caused by a single agent or more likely a combination of such factors as drought (in the spring), insect attack, competition, old age, etc. Variations in the percentage kill within similar treatments are likely due to such factors as variation in plant vigor, plant competition, soil texture, soil moisture, variation in amount of chemical or degree of mechanical injury per plant, and failure to treat all plants similarly and completely (the human error).

Grubbing was effective at all times of the year except on one plot where the kill was 72 percent. It is suspected that this was due to human error of application.

Mowing was an erratic treatment, but due to cheapness, simplicity, and ease of application, the method should be further tested particularly on more compact soil types.

Burning, with a flame gun, was ineffective on plots treated in January, when growth was being initiated. Burning during the dormant winter season thus appears to be ineffective. Although the results are erratic, burning at other seasons appears to be

effective, especially during the summer in July. However, burning at this time is difficult to achieve on account of the greenness and high moisture content of the plants. Burning, if done at all, should probably be accomplished during April, May, and June, provided that fuel conditions are such that burning can be safely undertaken with little or no danger of becoming uncontrollable. If done in the fall, as by broadcast burning, a year's supply is apt to be destroyed through uncontrolled fire. Data are being collected on the effect of burning on vegetation other than snakeweed.

The chlorate sprays, both Atlacide and sodium chlorate, were least effective on the plots treated in April, the typically dry period of the year. There appeared to be little difference between the two chemicals in effectiveness, and since Atlacide presents the least fire hazard, it should be given preference. Concentrations of 15 percent or greater are most effective and should be applied in the summer or early fall during the rainy season. Chlorate sprays, although expensive, can be used in situations where it is difficult to grub or inadvisable to burn, such as extremely rocky soils or brush covered areas. Its use no doubt is limited to small colonies which it is advisable to destroy because of seed production. Tests are being conducted on the effect of chlorates on perennial grasses and should be extended to the more compact soil types.

Heterogeneous mixtures of Colemanite or borate ore with sodium chlorate, although there is no fire hazard involved as with chlorate sprays, are less effective and more expensive.

Sulphuric acid sprays, kerosene and diesel oil were ineffective at all times and on all plots, and their use is not recommended. Diesel oil sprayed on snakewood plants followed about 10 days later by igniting the plants yielded rather erratic results, and is more expensive than burning with a flame gun.

The effects of various mechanical and chemical treatments on snakeweed
(*Gutierrezia sarothrae*)

| Treatment | MIDDLE STATION | | | | WEST STATION | | | |
|---------------------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| | Time of Treatment | | | | Time of Treatment | | | |
| | April | July | Octo- ber | Jan. 1939 | April | July | Octo- ber | Jan. 1939 |
| | Pct. plants killed | Pct. plants killed | Pct. plants killed | Pct. plants killed | Pct. plants killed | Pct. plants killed | Pct. plants killed | Pct. plants killed |
| None (check) | 5.9 | 0.0 | 0.0 | 0.0 | 13.0 | 0.0 | 0.0 | 4.2 |
| Grubbing | 98.5 | 100.0 | 72.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 |
| Mowing | 50.0 | 91.3 | 63.1 | 81.2 | 0.0 | 55.1 | 30.7 | 25.5 |
| Burning | 95.8 | 100.0 | 90.9 | 69.8 | 84.6 | 100.0 | 81.4 | 32.7 |
| 2.5% H ₂ SO ₄ * | 10.7 | 11.1 | 19.0 | 0.0 | 8.8 | 25.0 | 0.0 | 18.5 |
| 5.0% " | 5.9 | 11.4 | 13.4 | 0.0 | 4.3 | 5.9 | 0.0 | 3.8 |
| 7.5% " | 6.9 | 9.7 | 18.7 | 0.0 | 9.1 | 56.4 | 22.2 | 5.5 |
| 10.0% " | 8.8 | 55.9 | 0.0 | 63.0 | 9.1 | 48.3 | 44.4 | 13.0 |
| 5.0% Atlacide | 46.1 | 91.2 | 40.5 | 83.3 | 65.5 | 95.1 | 29.7 | 80.0 |
| 10.0% " | 24.4 | 84.8 | 60.5 | 79.4 | 58.1 | 100.0 | 79.5 | 100.0 |
| 15.0% " | 48.1 | 100.0 | 77.5 | 96.0 | 95.2 | 97.4 | 96.8 | 92.3 |
| 20.0% " | 78.8 | 100.0 | 94.7 | 100.0 | 91.3 | 98.4 | 87.2 | 100.0 |
| 25.0% " | 82.3 | 94.4 | 100.0 | 97.6 | 87.5 | 100.0 | 96.8 | 100.0 |
| 5.0% NaClO ₃ | 30.5 | 69.4 | 58.1 | 64.7 | 68.2 | 100.0 | 66.7 | 67.3 |
| 10.0% " | 50.0 | 98.1 | 93.7 | 100.0 | 95.8 | 97.0 | 92.6 | 96.8 |
| 15.0% " | 88.5 | 97.6 | 94.4 | 96.4 | 83.3 | 97.8 | 74.6 | 100.0 |
| 20.0% " | 69.2 | 100.0 | 100.0 | 100.0 | 83.3 | 100.0 | 100.0 | 100.0 |
| 25.0% " | 94.4 | 75.8 | 100.0 | 94.5 | 92.3 | 100.0 | 100.0 | 97.3 |
| Borate-NaClO ₃ 5:1** | 80.0 | 58.5 | 61.1 | 72.7 | 76.3 | 100.0 | 70.0 | 91.7 |
| " " 7:1 | 94.4 | 40.0 | 78.8 | 45.4 | 63.6 | 91.3 | 55.1 | 83.7 |
| " " 10:1 | 47.5 | 66.7 | 59.4 | 85.7 | 40.0 | 85.2 | 47.4 | 76.5 |
| " " 20:1 | 19.3 | 55.9 | 23.7 | 44.4 | 47.8 | 72.0 | 27.6 | 53.8 |
| Kerosene | 9.1 | 3.2 | 0.0 | 0.0 | 8.3 | 10.3 | 23.0 | 65.2 |
| Diesel Oil | 9.8 | 37.9 | 2.8 | 13.2 | 15.4 | 35.7 | 0.0 | 0.0 |
| Diesel Oil followed by burning | 95.4 | 85.3 | 23.5 | 20.9 | 45.4 | 77.6 | 75.6 | 38.2 |

*Concentration expressed as percentage by dry weight.

**Parts borate ore to parts sodium chlorate by dry weight applied as a dust;
other chemicals were applied in spray form as aqueous solutions or full
strength liquids.

RANGE PLANTS

Southwestern

Forage Values

Forage production. That volume of forage produced is closely related to the percentage of ground actually occupied by living grasses has long been recognized, but there has been a question in the minds of men engaged in range management as to whether the volume of forage on the range is directly proportioned to the density.

It has been repeatedly observed that under protection there may be a loss of density, but there is an increase in volume due to increased height growth. Conversely, under moderate grazing there is a tendency for the grass plants to stool out and occupy a greater proportion of the ground, but the volume of forage may be no greater than is found on the lower density under protection. It may easily follow that on grassland ranges where rainfall is a limiting factor changes in density may not result in a proportional change in the amount of forage produced. This tendency was indicated in the analysis of the past season's records for the grama forage study on the Jornada Experimental Range in which it was noted that the randomly located plots showed considerable variation in density and in production of forage. These data, as shown in the following table, indicate forage production expressed in pounds of forage per acre which may be expected with different degrees of ground cover (expressed in percent) as determined for the particular area upon which the measurements were made.

| Ground Cover ^{1/} | Forage produced expressed in terms of pounds per acre ^{2/} | |
|----------------------------|---|---|
| | Black Grama | Other grasses, mostly Aristida and Sporobolus |
| <u>Percent</u> | <u>Pounds</u> | <u>Pounds</u> |
| 1 | 368 | 271 |
| 2 | 510 | 389 |
| 3 | 652 | 507 |
| 4 | 794 | 624 |
| 5 | 936 | 742 |
| 6 | 1078 | 860 |
| Correlation coefficient | 0.8999 | 0.8267 |

^{1/}Ground cover was determined for each species by single dimensional measurements along a line running lengthwise through clipped plots.

^{2/}Based on forage produced on 64 plots, each 2'x25'.

The percent of ground occupied by grasses was determined from measurements made at the level of the ground on 64 25-foot line transects, and the corresponding weight of grass was determined by clipping and weighing the forage obtained from belt transects 2 feet wide and 25 feet long which in each case had the measured line transect as its longitudinal axis.

In no case did double or triple density give twice and three times the volume of forage; in fact, the increase in density of black grama from 1 to 6 percent only gives 2.9 times the volume obtained at 1 percent. A similar comparison of densities and corresponding volumes for grasses commonly associated with black grama shows a sixfold increase in density as giving an increase in volume of 3.2 times that of the 1 percent density. The correlation between density and volume as shown is sufficiently high to support the conclusion that under the experimental conditions increases in volume are not directly proportional to increases in density. If this is universally true it may be that density-volume adjustments should be provided for in range surveys.

COOPERATING BUREAU PROJECTS

BIOLOGY

(In Cooperation with The Bureau of Biological Survey)

Lake States

White Cedar Clipping Study. A study has been initiated at the Upper Peninsula experiment station under the direction of Shaler E. Aldous of the Biological Survey to determine a more accurate basis for estimating the amount of food available and the number of deer that may be maintained on an area.

Because deer in this region have a marked preference for white cedar browse, the study was made on this species. A number of young trees were clipped of 25 and 50 percent of their foliage to determine the amount of browsing young cedar can endure and still maintain satisfactory growth. In the second part of the study 75 trees were completely defoliated to determine the amount of food made available to the deer when trees of various sizes are felled by storm or in logging operations.

ENTOMOLOGY

(In Cooperation With the Bureau of Entomology & Plant Quarantine)

Southern

Christian, at Tallulah, La., reports that the egg of Lyctus parallelopipedus Melsh and the depth of deposition in wood is different from that of L. planicollis Lec. This may affect the application of chemical treatments. A large series of tests are under way with live beetles in the cages.

On May 13, Major Ware of the Chicago Mill and Lumber Company, and Mr. Christian consulted with Snyder at New Orleans before using 5-percent borax dips on a commercial scale to prevent Lyctus attack. Christian has obtained infestation by Lyctus in wood containing greater than 15-percent moisture content, but as yet there has been no development of larvae. Two-percent pentachlorophenol in petroleum oil has failed to prevent attack by Lyctus.

Johnston, at Saucier, Miss., is studying the biology of ambrosia beetles and their relation to fungi, with the assistance of Dr. Verrall of B.P.I. Johnston is also working on various termite tests and is supervising the construction of an insectary for rearing forest insects. On March 31 an inspection was made of the Ashe Nursery at Brooklyn, Miss.; and no insect damage was found; light traps will be installed later.

PATHOLOGY

(In Cooperation with the Bureau of Plant Industry)

Northeastern

Salt spray injury: In order to determine the effect of salt spray on survival of affected trees, three plots were established in the area of most intense injury near Mattapoisett, Massachusetts, in Pinus strobus stands. This species appears to have been most severely injured. Many burned needles have fallen. What the effect of various degrees of defoliation may be, the survival of buds and growth made by them, and possible attacks of weakly parasitic fungi on the weakened trees are questions which it is hoped may be answered.

Douglas fir leaf cast: In 1937 a serious leaf shodding disease of Douglas fir was reported in England, Switzerland, Austria, and Germany. Last year it was discovered by the Connecticut Agricultural Experiment Station in a plantation at Willington, Connecticut. Since then it has been found at Dover and Chester, New Hampshire; Petersham and Hamilton, Massachusetts; and Warwick, Rhode Island. The disease attacks needles more than one year old, causing them to fall prematurely. After a few years a diseased tree may have left only the youngest needles, and apparently slowly dies from lack of nutrition. Our native North American species of *Abies* often have a closely related fungus which is but weakly, if at all, parasitic. So far as known, the Douglas fir fungus is limited to Pseudotsuga. While Douglas fir is relatively unimportant in the Northeast, it appears that its future use here is hazardous.

COMMENTS

Assistant Chief, Forest Service,
In Charge, Forest Research,
Washington, D. C.

Dear Sir:

The character of material included in the bi-monthly report has been frequently questioned and criticized. I should like to compliment the fire danger measurement section of the Appalachian Station report for April. Gisborne tells me that in this opinion this is the most informative, helpful, and therefore valuable section that he has ever seen from any station.

Very truly yours,

M. BRADNER,
Director,

By /s/ Kenneth Davis
Acting

PUBLICATIONS

MANUSCRIPTS

California

Fowells, H. A., and
Arnold, R. K.

Hardware cloth seed-spot screens
reduce high surface soil temper-
atures. (For Journal of Forestry.)

Schreiber, B. O.

Vegetation type map herbarium. (To
Chronica Botanica.)

Wieslander, A. E.

Vegetation survey and type map of
California and western Nevada. To
Chronica Botanica.)

Wieslander, A. E.

Utilization of air photographs in
the vegetation survey of California
and western Nevada. (To Chronica
Botanica.)

Lake States

LeBarron, R. K.

The role of forest fires in the
reproduction of black spruce.
(Minnesota Academy of Science)

Northern Rocky Mountain

Whitney, C. N., and
Hutchison, S. B.

Consumption of timber products in
the northern Rocky Mountain region.

Pacific Northwest

Morris, Wm. G.

Number of fire weather stations
necessary on each ranger district
of the national forests in Oregon
and Washington. (For Jour. of For.)

Morris, Wm. G. Statistical analysis of fire weather station distribution. (For Jour. of For.)

Welch, Douglass C. Growth of a Douglas fir plantation. Report on the 1939 remeasurement of the Siuslaw permanent sample plots nos. 11, 12, 13, and 14, in the Hebo plantation. May 11, 1939.

Southern

Liefeld, T. A. A simple, efficient sign-stenciling apparatus. (To Journal of Forestry.)

Liefeld, T. A. Marking and numbering trees with paint in stick form. (To Journal of Forestry.)

Southwestern

Lexen, Bert R. Growth following partial cutting in ponderosa pine. (To Journal of Forestry.)

Parker, Kenneth W. Prevention of death losses from Pingue. (For The National Wool Grower.)

Parker, Kenneth W. Manzanita (Arctostaphylos spp., member of Heath family). (To Arizona Visitor's Guide.)

Parker, Kenneth W. Mountain Mahogany (Cercocarpus spp., member of the Rose family). (To Arizona Visitor's Guide.)

Parker, Kenneth W. Tesota, or Ironwood (Olneya tesota, member of the Pea family). (To Arizona Visitor's Guide.)

Pearson, G. A. Cork-bark fir. (To Arizona Visitor's Guide.)

- Pearson, G. A. Growth and mortality of ponderosa pine in relation to size of trees and method of cutting. (To Journal of Forestry.)
- Pearson, G. A. The Fort Valley Experimental Forest. Silvical data and plan of management. (For USDA Bul.)

TECHNICAL NOTES

Lake States

- No. 143. Thinning of conifer seedlings in the nursery produces bigger but fewer plantable trees. April 1939.
144. Beneficial effect of partial shade on field survival. April 1939.
145. Top-pruning of conifer stock a doubtful operation. April 1939.
146. Black spruce maintains a year-round seed supply. April 1939.
147. Black spruce seed is a limited air traveler. April 1939.
148. Jack pine seed habits. April 1939.
149. When do jack pine seeds germinate? April 1939.
150. Effect of utilization standards on pulpwood yield. April 1939.
151. Pulpwood volume losses due to peeling and shrinkage. April 1939.
152. Comparative resistance of native Wisconsin trees to snow breakage. April 1939.
153. A fast-growing and winter-hardy poplar hybrid still to be found for the Lake States. April 1939.
154. Twenty-five years of forest fires in the Lake States. April 1939.
155. Taper table for jack pine. April 1939.

MIMEOGRAPHED RESEARCH NOTES

Southwestern

- No. 53. Total height volume table for the southwestern white pines.
54. Total height volume table for white fir.
55. Merchantable height volume table for Apache pine.
56. Merchantable height volume table for Arizona pine.
57. Merchantable height volume table for Chihuahua pine.
58. Suggestions for estimating pinon nut crops.
59. The influence of release in relation to diameter growth of ponderosa pine.

IN PRINT

- Abell, C. A. A method of estimating area in irregularly shaped and broken figures. (Journal of Forestry, April 1939.)
- Ares, Fred N. Utilization. (American Herford Journal, April 1, 1939.)
- Bruce, H. D. The role of chemicals in firebreak maintenance. (Utah Juniper, 1939.)
- Buell, E. D. Forest statistics for Pacific County, Washington. (Mimeo. April 10, 1939.)
- Buell, E. D. Forest statistics for Pierce County, Washington. (Mimeo. May 15, 1939.)
- Buell, J. H. Hand-riven shingles - a pioneer art revived. (American Forests 45: 272.)
- Bull, Henry The relation of forest research to the farm chemurgic movement in Arkansas. (Presented at Second Chemurgic Conference of Arkansas Council of Agriculture, Science, and Industry, Little Rock, Ark., May 3, 1939. Mimeographed in Proceedings of the Conference.)

- Burks, G. F., and
Wilson, R. C. A vegetation inventory from aerial
photographs. (Photogrammetric
Engineering. January-March, 1939.)
- Burleigh, T. D. Second record of Brewer's blackbird
in Alabama. (The Auk. July 1938.)
- Burleigh, T. D. The Mexican turkey vulture in sou-
thern Florida. (The Auk. July 1938.)
- Canfield, Roy H. Semideferred grazing on black grama
range. (Cattle Producer. April 1939.
Also appeared as Research Note No. 35.)
- Chapman, R. A. Nursery inventory procedure. (Southern
Forestry Notes, No. 27, May 1939.)
- Culley, Matt J. Rodents or cattle. (Western Livestock
Journal. March 28, 1939.)
- Davis, Kenneth P., and
Klehm, Karl A. Controlled burning in the western white
pine type. (Journal Forestry, May
1939.)
- Davis, W. E. Measurement of precipitation above
forest canopies. (Journal of Forestry,
April 1939.)
- Eyre, F. H. Common-sense appraisals for small
timber sales. Service Bulletin,
Vol. 23, No. 8, April 17, 1939.
- Eyre, Francis H., and
Neetzel, John R. Practical cutting methods for northern
hardwoods. (Papers Mich. Acad. Sci.,
Arts and Letters 24(Part I): 197-208.
1938. Published 1939.)
- Gisborne, H. T. (Hornby's principles of fire-control
planning. Journal of Forestry). April
1939.
- Gisborne, H. T. Determination of normal fire danger.
(The Ames Forester, 1938.)
- Gisborne, H. T. Fire danger meter design. (The Utah
Juniper, 1939.)
- Glendening, George E. The place of tanglehead in artificial
revegetation. (Arizona Stockman.
February 1939. Also appeared as Re-
search Note No. 37.)

- Goodell, B. C. A Soil Boring Tool for Frost Depth Determination (Jour. of For., June, 1939.)
- Heyward, Frank Some moisture relationships of soils from burned and unburned longleaf pine forests. (Soil Science, April 1939.)
- Heyward, Frank The relation of fire to stand composition of longleaf pine forests. (Ecology, April 1939.)
- Hicks, W. T. Economic aspects of cooperative marketing of forest products. (Jour. Forestry, April 1939.)
- Hornibrook, E. M. A Modified Tree Classification for Use in Growth Studies and Timber Marking in Black Hills Ponderosa Pine. (Jour. of For., June 1939.)
- Hursh, C. R. Low cost erosion control on highway slopes in southeastern U. S. By John E. Snyder and Charles R. Hursh. (Proc. Highway Research Board., 1938.)
- Isaac, Leo A. A sign that tells the story. (Jour. of For., May 1939.)
- Jensen, H. A. The vegetation types and forest conditions of the Santa Cruz Mts. unit. Berkeley, Calif., 1939. 55 pp. California Forest and Range Experiment Station. (Forest Survey Release No. 1.)
- LeBarron, R. K., and Eyre, F. H. The release of seeds from Jack pine cones. (Jour. For. 37: 305-309. April 1939.)
- Little, Elbert L., Jr. Botrychium lanceolatum in Arizona. (American Fern Journal. January-March 1939.)
- McArdle, R. E. Forestry research. (The Cruiser, Yearbook of the Forestry Club, West Virginia University. 1939.)

- Munger, Thornton T. The silviculture of tree selection cutting in the Douglas fir region. (U. of W. Forest Club Quarterly, vol. XII, no. 2.)
- Muntz, H. H., and Wakeley, P. C. Nursery-soil amendmets other than fertilizer. (Southern Forestry Notes No. 27, issued by the Southern Forest Experiment Station, May 1939.)
- Osborne, J. G. A design for experiments in thinning forest stands. (Journal of Forestry, April 1939.)
- Pearson, G. A. Mortality in cutover stands of ponderosa pine. (Journal of Forestry. May 1939.)
- Rapraeger, E. F. Range of log prices 1938, northern Rocky Mountain region. (The Timberman, May 1939.)
- Rudolf, Paul O. Why forest plantations fail. (Jour. For. 37: 377-382. May 1939.)
- Schreiner, Ernst J. Some Ecological Aspects of Forest Genetics. (Jour. of For., June 1939.)
- Shirley, Hardy L. Review of "Tree Growth" by Daniel T. MacDougal. (Jour. For. 37: 426-427. May 1939.)
- Snyder, T. E. Isoptera, family Rhinotermitidae, Reticulitermes creedei n. sp. A new fossil termite from the Miocene. In: Carpenter, F. M., and others, Fossil insects from the Creede Formation, Colorado. Psyche 45 (2-3): 109-110, illus. Sept. 1938.
- Snyder, T. E. The present status of the Lyctus problem. (Year Book National Hardwood Lumber Assn., October 1938.)

- Snyder, T. E. The termite problem and recent research
(Presented before National Pest Control
Assoc. Memphis, Tenn., Oct. 25, 1937.)
Exterminators Log 6 (3): 6-9, illus.
March 1938.
- Stockwell, W. P. Cone variation in digger pine (Madrono,
April 1939.)
- Sutton, George Miksch, and
Burleigh, Thomas D. A list of birds observed on the 1938
Semple Expedition to Northeastern
Mexico. (Occasional Papers of the
Museum of Zoology of the Louisiana
State University, April 5, 1939.)
- Upton, Arthur, and
McGinnies, Wm. G. Range research contributes to pro-
gress in range management. (The
Cattleman, April 1939.)
- Valentine, Kenneth A. The proper use of tobosa grass range.
Arizona Stockman. (April 1939, Also
appeared as Research Note No. 38.)
- Winters, Robert K. Fuelwood Consumption in the Lower
South (Jour. of For. June 1939.)